Sediment Characterization Sampling and Analysis Plan (SAP) for the Levin-Richmond Terminal Corporation Berth A

Maintenance Dredging Program: Episode 3

USACE: Permit 2008-00399S
RWQCB: File #: 741898 (EAC)
BCDC: M82-7 Amendment 7

Prepared for

Levin-Richmond Terminal Corporation
402 Wright Avenue
Richmond, CA 94804

Prepared by

Pacific EcoRisk
2250 Cordelia Road
Fairfield, CA 94534

March 2012

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Ms. Debra O'Leary
U.S. Army Corps of Engineers
San Francisco District
1455 Market Street
San Francisco, CA 94103-1398

March 6, 2012

Dear Ms. O'Leary:

On behalf of Mr. Jim Cannon of the Levin-Richmond Terminal Corporation (LRTC), please find enclosed for review at the March 14th DMMO meeting, two (2) copies of the report "Sediment Characterization Sampling and Analysis Plan (SAP) for the Levin-Richmond Terminal Corporation Berth A" in support of the LRTC maintenance dredging program. In addition, one copy of this SAP has been sent to the other DMMO participating agency representatives. This SAP has been prepared to support advanced maintenance dredging of approximately 13,990 cubic yards of material from LRTC's Berth A.

If you have any questions, please give me a call at (707) 207-7761. I look forward to hearing from you.

Sincerely,

R. Scott Jeffrey, for

Jeffrey Cotsifas
President

cc (w/enc): Melissa Scianni, U.S. EPA
Brenda Goeden, BCDC
Beth Christian, SFRWQCB
Donn Oetzel, SLC
Jim Cannon, LRTC

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ASTM	American Society for Testing and Materials
Bay	San Francisco Bay
BCDC	Bay Conservation and Development Commission
COC	Chain-of-custody
Calscience	Calscience Environmental Laboratories, Inc.
CV	Coefficient-of-variation
CY	Cubic yards
DMMO	Dredged Material Management Office
DU	Dredge unit
ESC	Elutriate Suitability Concentrations
GPS	Global positioning system
HDPE	High density polyethylene
HWRP	Hamilton Wetland Restoration Project
ITM	Inland Testing Manual
LRTC	Levin-Richmond Terminal Corporation
MLLW	Mean lower low water
MRL	Method reporting limits
MWP	Montezuma Wetlands Project
NUAD	Not suitable for unconfined aquatic disposal
OTM	Ocean Testing Manual
PER	Pacific EcoRisk
QA/QC	Quality assurance/quality control
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
RPD	Relative percent difference
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SF-DODS	San Francisco Deep Ocean Disposal Site
SLC	State Lands Commission
SAR	Sampling and Analysis Report
SET	Standard elutriate test
SOP	Standard operating procedures
SUAD	Suitable for unconfined aquatic disposal

TEG	TEG Oceanographic Services
TOC	Total organic carbon
TRV	Toxicity reference values
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFDA	U.S Food & Drug Administration
WAAS	Wide angle augmentation system
WET	Waste extraction test

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Penny Reddy - EPA Heckathorn staff lead

1. INTRODUCTION

The Levin-Richmond Terminal Corporation (LRTC), located in the Richmond Inner Harbor Channel in Richmond, CA, (Figures 1-1 through 1-3), currently maintains 10-year permits from the U.S. Army Corps of Engineers (USACE), the Bay Conservation and Development Commission (BCDC) and a water quality certification from the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) for maintenance dredging of their Berth A. The LRTC Berth A is adjacent to the former United Heckathorn Superfund site. While the U.S. EPA has performed a clean-up at the site, residual DDT and dieldrin are still present in the Lauritzen Channel (Figure 1-3).

LRTC has contracted Pacific EcoRisk (PER) to perform sampling and testing of its Berth A sediments in support of the third maintenance dredging episode under the new permits. This third episode will consist of "advanced" maintenance dredging activities. The advanced maintenance dredging is being performed to determine if the periodicity of maintenance dredging at Berth A can be decreased by: 1) dredging a trench along the face of the Berth B wharf to -45 ft MLLW, and 2) dredging of the entire berth to the permitted over-depth tolerance of -41 ft MLLW. LRTC currently requires annual dredging maintenance dredging of its Berth A to maintain berthing vessel safety.

Ever been dredged this deep before?

-39 +2

NO

The Berth A permitted maintenance dredge depth is 39 ft below Mean Lower Low Water (-39 ft MLLW) plus a two-foot over dredge tolerance, resulting in a project depth of -41 ft MLLW. Proposed advanced maintenance dredging activities would allow for dredging of a trench along the face of the Berth A wharf to -45 ft MLLW plus a one-foot over-dredge tolerance (-46 ft MLLW) and -41 ft MLLW plus a one-foot over-dredge tolerance (-42 ft MLLW) throughout the reminder of the berth. The Episode 3 estimated total volume of dredged material to be removed from Berth A, including material accounted for by the one-foot over dredge tolerance, is estimated at 13,990 cubic yards (yds^3).

Salt wording: 39+3, w 2' pond + 1' non-pay

why? in permits?

Table 1-1. Proposed Episode 3 Maintenance Dredging for the Levin-Richmond Terminal Corporation.

Area	Dredge Unit	Maintenance Dredging Permitted Depth (ft MLLW)	Over-depth (ft)	Advanced Maintenance Dredging Depth	Estimated Volume (yds^3)	Over-depth (ft)	Estimated Volume (yds^3)	Total Estimated Volume (yds^3)
Berth A Trench	DU1	-39.0	2.0	-45.0	3,500	1.0	330	3,800
Berth A	DU2	-39.0	2.0	-41.0	6,300	1.0	3890	10,190
Totals					**9,800**	**1.0**	**4,220**	**13,990**

entire area

pretty much already at -41 ft

Testing of LRTC Berth A sediments in 2005 indicated that the sediments were suitable for "deep-cell" disposal at the Montezuma Wetlands Project (MWP); results of 2008 testing indicated that sediment were suitable for re-handling at the Port of Oakland's Berth 10 or onsite (LRTC property) prior to subsequent disposal at a land fill. It is anticipated that future dredged material will also be disposed of in either a land fill, or "deep-cells" at MWP as long as there is available capacity and sediment quality is of similar nature. However, since sediment quality may vary over time and in the event that other disposal options, such as the San Francisco Deep Ocean Disposal Site (SF-DODS) or other suitable sites, become viable options based on the results of the chemical and biological analysis of the sediments, this Sampling and Analysis Plan (SAP) covers sampling and testing for a variety of disposal site options so as to ensure flexibility for the LRTC maintenance-dredging program.

This SAP is being prepared in support of "advanced" maintenance dredging in which the LRTC is proposing to dredge depositional material from Berth A, and has been developed in accordance with currently applicable guidance and establishes the general approach to sampling and assessment of sediments proposed for dredging.

1.1 Objectives of the Sediment Investigation

The purpose of the proposed sampling and testing will be to evaluate the proposed dredged material to determine whether it will represent an adverse impact during removal operations and placement at currently permitted disposal sites and/or future alternative disposal sites. The procedures for sediment sample collection, sample processing and preparation, physical and chemical analyses, biological testing and data analyses are presented in this SAP. The specific objectives of the SAP scope-of-work are as follows:

- Collect core samples from within the designated sampling areas following field protocol detailed in this SAP; and
- Conduct chemical analysis to determine whether sediments may be a candidate for placement at SF-DODS. If the results of chemical analysis indicate that sediments may be suitable for unconfined aquatic disposal (SUAD), the required biological analyses to determine suitability for placement at SF-DODS will be performed. Samples will be archived to provide for any landfill placement site-specific requirements (i.e., waste extraction testing [WET]), if sediments are determined not suitable for unconfined aquatic disposal (NUAD) at SF-DODS.

Guidance concerning necessary sampling and analytical protocols, quality assurance/quality control (QA/QC) procedures, and data interpretation can be found in:

- Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual (OTM; USEPA/USACE 1991);
- Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual (ITM; USEPA/USACE 1998);

- Public Notice 01-1: Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region;
- Public Notice 99-4: Proposed Guidance for Sampling and Analysis Plans (Quality Assurance Project Plans) for Dredging Projects within the USACE San Francisco District;
- Public Notice 93-2: Testing Guidelines for Dredged Material Disposal at San Francisco Bay Sites;
- DMMO Agreement on Programmatic EFH Conservation Measures for Maintenance Dredging Conducted Under LTMS Program -Tracking Number 2009/06769 (USEPA/USACE. 2011); and
- The DMMO review process.

1.2 Overview of Field Activities and Lab Analyses

Sampling and analysis will be performed on sediments collected from the proposed locations (Figure 1-4); a typical cross section for the proposed dredging is presented in Figure 1-5. A brief overview of the field activities and lab analyses is presented below. A detailed description is presented in Sections 4 and 5.

Sampling and Testing Program

The testing portion of the program will be performed in a tiered process with the assessment of sediment chemical concentrations being performed prior to any other testing. If the analytical chemistry results indicate that sediments may be SUAD, then the biological testing component of this program will be implemented. Otherwise, "deep-cell" placement at the MWP, a landfill, or other appropriate alternative will be pursued.

Berth A Trench (DU1)

STATE: INDIV. CORE CHEM UP FRONT, + COMP CHEM, + COMP BIOASSAYS

Using an appropriate coring device, four sediment cores will be collected to the advanced maintenance project depth of -46.0 ft MLLW (the project depth + 1 ft over-depth) plus an additional 0.5 ft for the characterization of the "Z" layer (the expected post-dredging mudline); the total cored depth will be -46.5 ft MLLW (Figure 1-4). Prior to any homogenization of the individual core samples, the "Z" layers will be removed and processed separately.

SHOULD ALSO DO Z UP FRONT (CHEM) + (COMP OR CORE?)

Berth A (DU2)

Four sediment cores will be collected to advanced maintenance project depth of -42.0 ft MLLW (the project depth + 1 ft over-depth) plus an additional 0.5 ft for the characterization of the "Z" layer; the total cored depth will be -42.5 ft MLLW (Figure 1-3). Prior to any homogenization of the individual core samples, the "Z" layers will be removed and processed separately.

DO UP FRONT

Each of the sediment cores for each DU will be individually homogenized and a sub-sample of the homogenized sediment from each core will be archived for subsequent analyses of the individual core sediment, if needed. Proportionate amounts of the homogenized sediment from each of the individual sediment cores will be composited and homogenized to form the composite samples for DU1 and DU2. Samples of the composited sediments will be submitted

for chemical and conventional analyses, with the remainder of the composite samples being archived for subsequent biological analysis if needed. After review of the analytical chemistry data, toxicity testing and bioaccumulation testing may be performed. The 'Z-layer' samples will be processed in a similar fashion and archived for analysis, if needed. The conventional and chemical analyses will be performed such that results can be obtained and biological testing initiated within the 8-week sample hold time.

Data Interpretation

The results of these sediment analyses will be used to determine the suitability of the proposed sediments for placement at a landfill or other appropriate site such as the MWP. Analytical chemistry results will be compared to disposal location site-specific requirements, and Bay residuals testing trigger levels (US EPA/USACE 2011). Should the sediments qualify for unconfined aquatic disposal at SF-DODS, suitability for dredging and disposal with respect to analytical chemistry will be determined by comparison to the SF-DODS reference site database and the DMMO review process; biological testing will be compared to the SF-DODS reference site database.

All project dredged material determined to be SUAD is anticipated to be disposed at SF-DODS; sediments determined to be NUAD will be re-handled on-site with subsequent placement at a landfill. However, other options, such as placement at the MWP, will be considered should they present a cost-effective alternative to landfill disposal.

1.3 DMMO Agency Review and Permitting

The federal and state agencies responsible for regulating dredged material programs in the San Francisco Bay area include:

- U.S. Environmental Protection Agency (USEPA) Region 9,
- U.S. Army Corps of Engineers (USACE),
- San Francisco Regional Water Quality Control Board (RWQCB),
- San Francisco Bay Conservation and Development Commission (BCDC), and
- State Lands Commission (SLC).

Representatives from these agencies comprise the Dredged Material Management Office (DMMO).

Under a permit or/certification from each of the DMMO Agencies, LRTC is authorized to conduct maintenance dredging at its Berth A. Each of the permits required to perform dredging in these basins are listed below:

USACE: Permit 2008-00399S
RWQCB: File #: 741898 (EAC)
BCDC: M82-7 Amendment 7

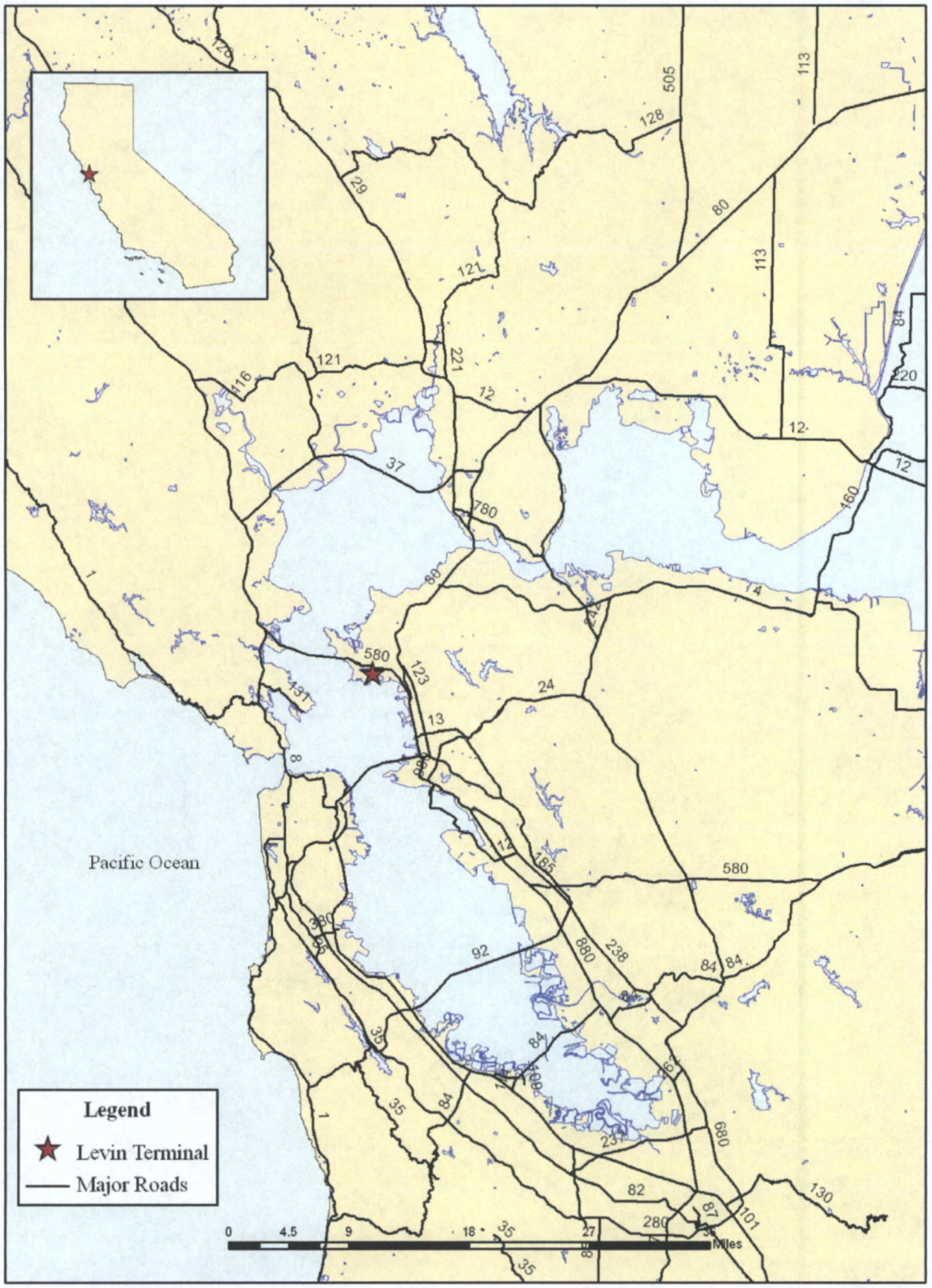


Figure 1-1. Location Map: Levin-Richmond Terminal Corporation

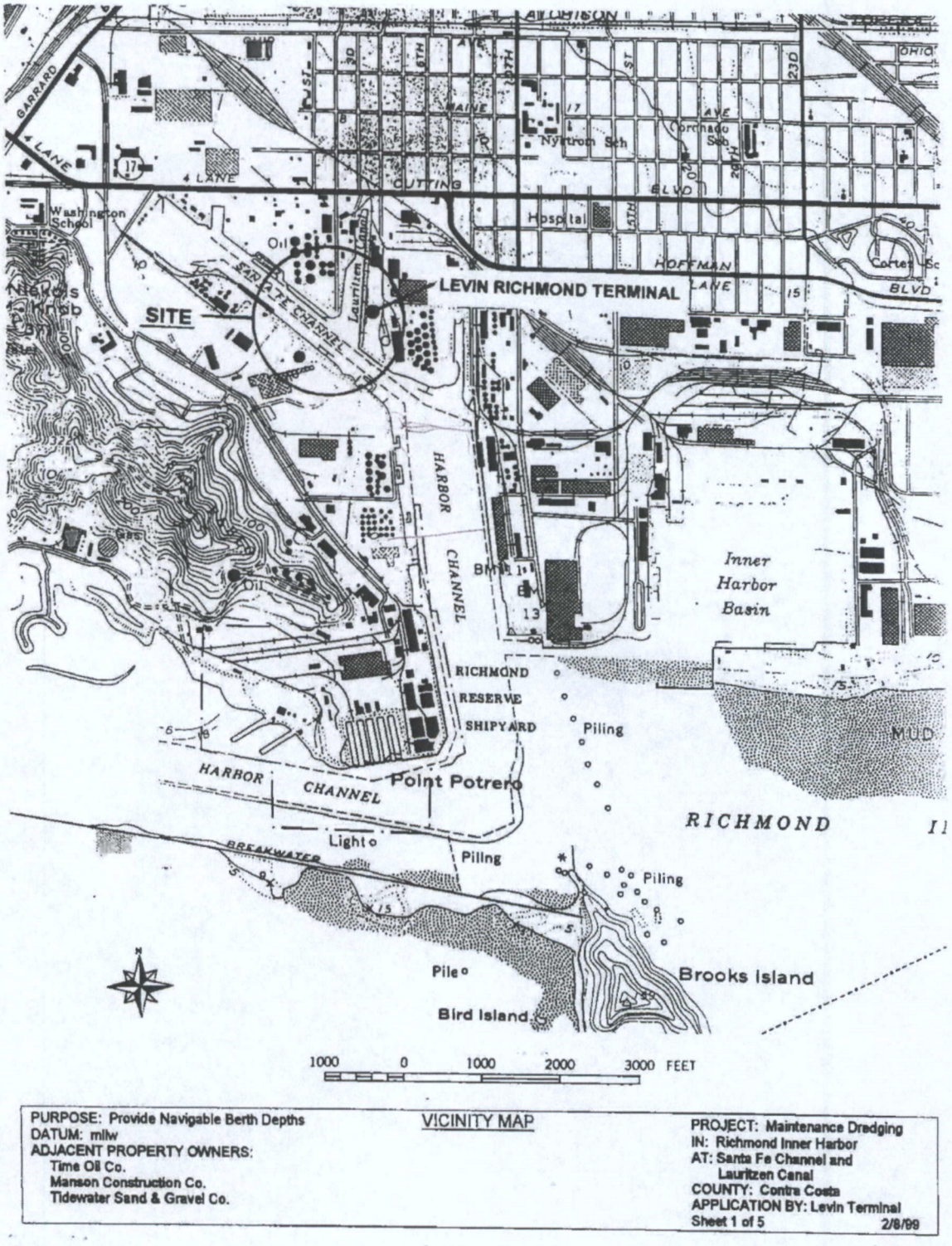


Figure 1-2. Vicinity Map 1: Levin-Richmond Terminal Corporation

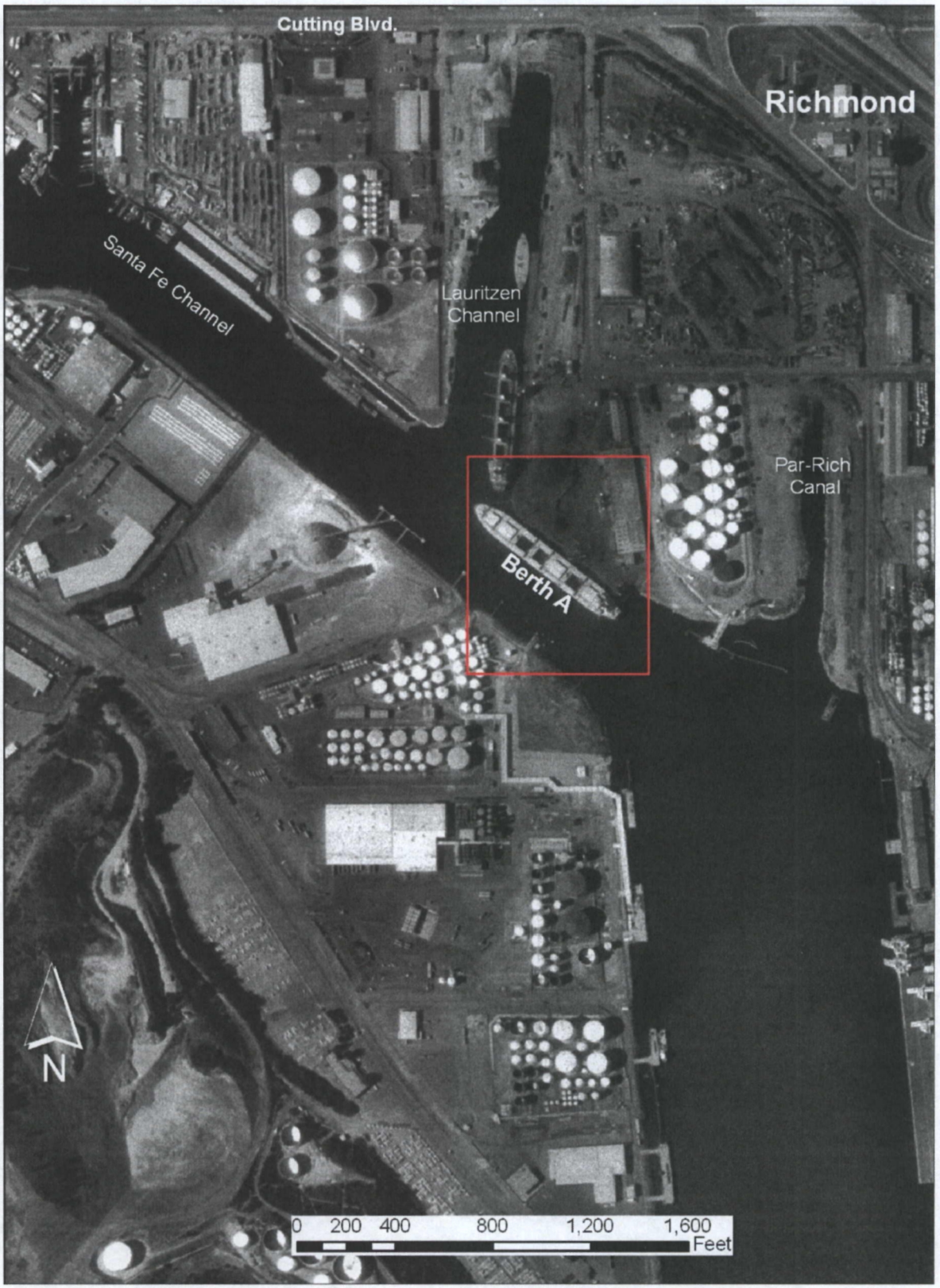


Figure 1-3. Vicinity Map 2: Levin-Richmond Terminal Corporation Berth A

Dredge Areas in 2010+2011?

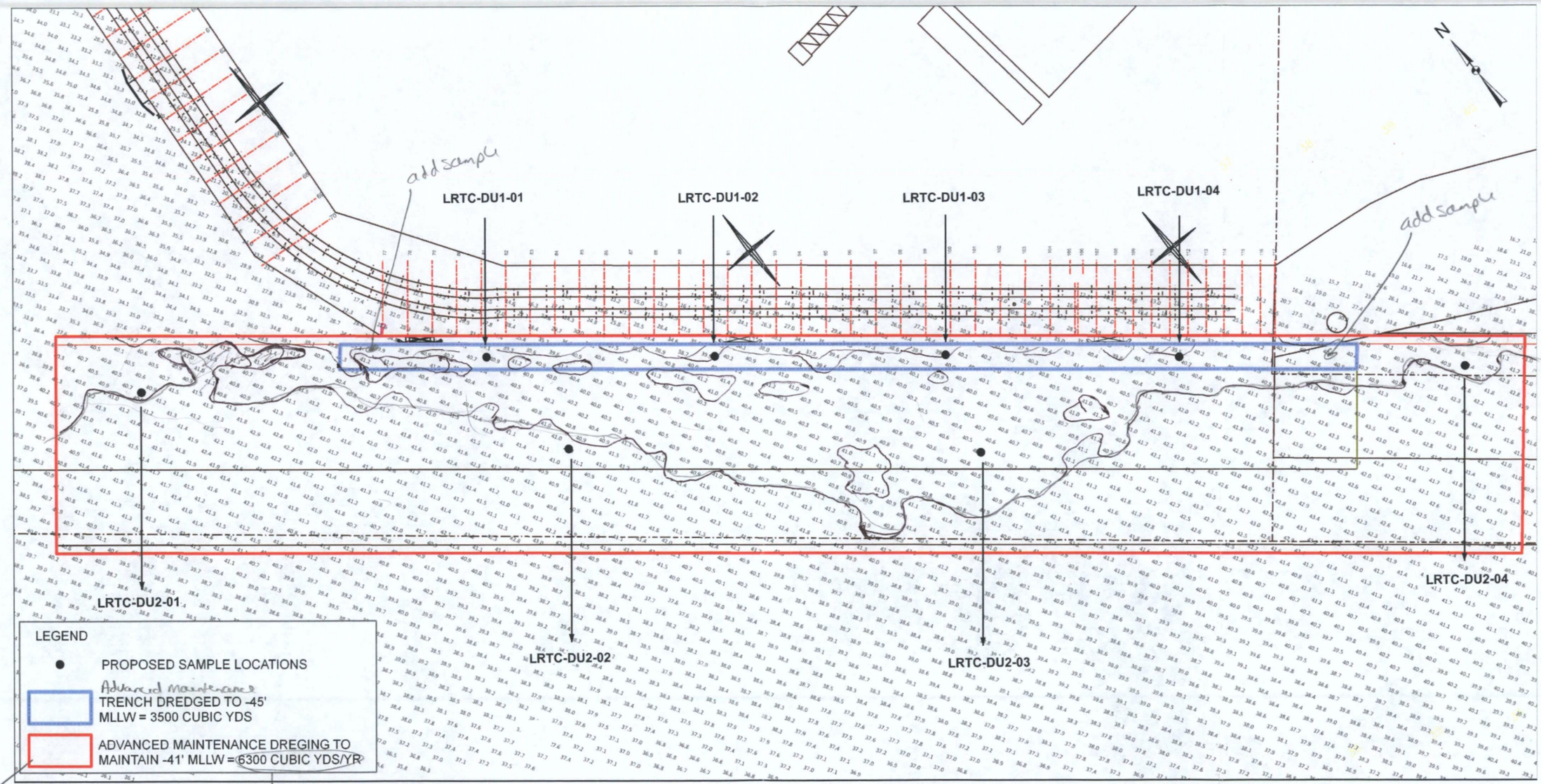


Figure 1-4. Project Map: Levin-Richmond Terminal Berth "A" Sample Locations

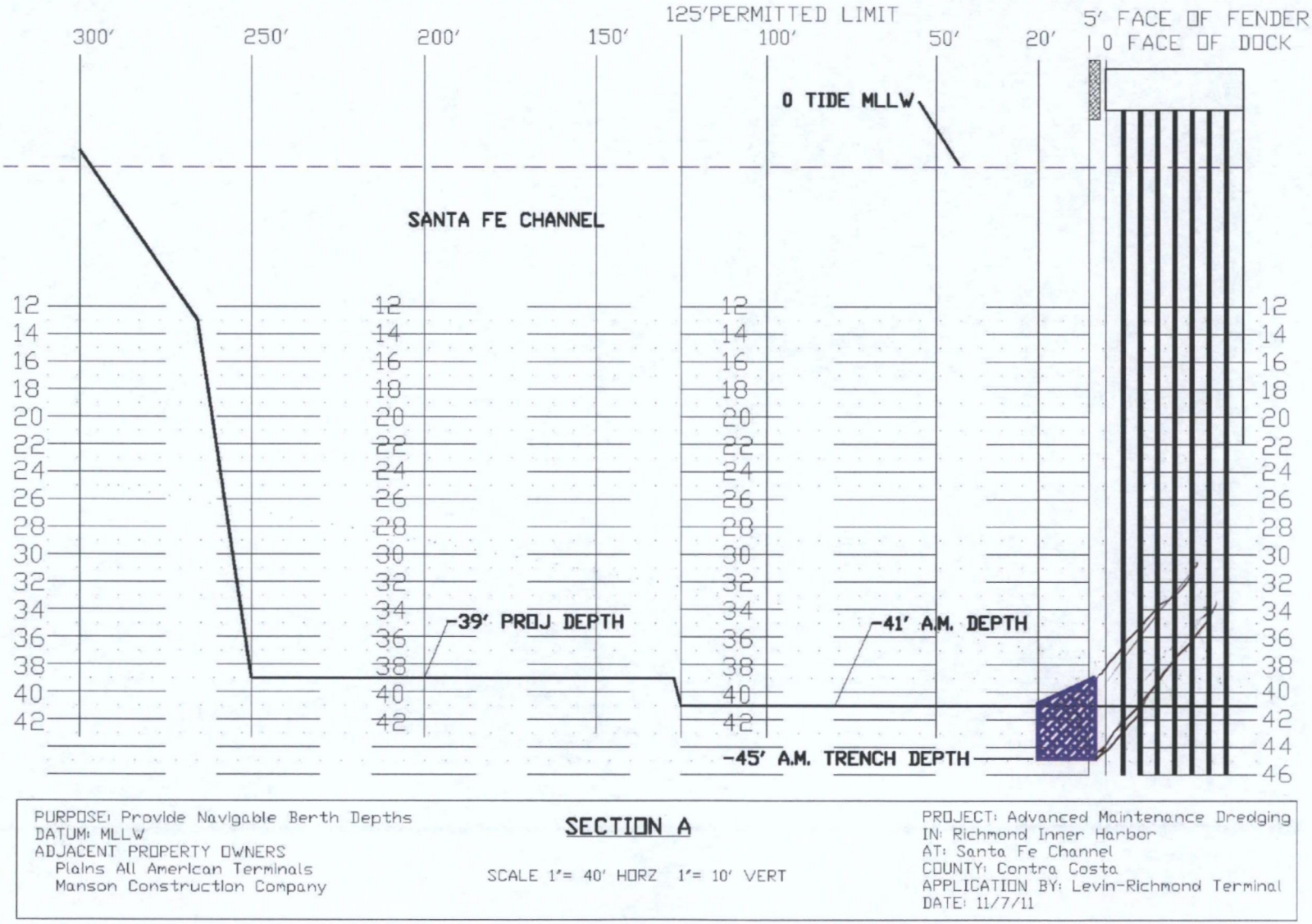


Figure 1-5. Project Map: Levin-Richmond Terminal Berth "A" Cross Section

2. PROJECT MANAGEMENT AND RESPONSIBILITIES

2.1 Program and Field Activities

Mr. Jim Cannon (of LRTC) will be the Project Manager. The Sampling and Analysis Project Manager for the primary contractor will be Mr. Jeff Cotsifas (of PER), assisted by Dr. Scott Ogle. Mr. Cotsifas will be responsible for overall project coordination, including collection and submittal of environmental samples to the designated laboratories for chemical and physical analyses, data analyses production of all project deliverables, and administrative coordination to assure timely and successful completion of the project. Mr. Cotsifas will also be responsible for all decisions concerning sample collection, for QA/QC oversight, and ensuring that appropriate protocols for decontamination, sample preservation, and holding times are observed. Mr. Cotsifas will be involved in all aspects of this project, including preparation, and approval of the SAP, and review and interpretation of all analytical results; Dr. Ogle will be involved in review and interpretation of all analytical results. The project management organization is illustrated in Figure 2-1.

All field activities will be performed under the direction of Mr. Cotsifas. Sediment cores will be collected by TEG Oceanographic Services (TEG) and PER. During collection of sediment cores, the sampling vessel will be staffed with a captain, operating crew, and 2 field scientists. Mr. Mark Mertz of TEG will captain the sampling vessel, and will be responsible for location control and positioning, and providing all coring devices and operating crew. PER will supply a Field Manager and Field Scientist.

2.2 Project Management

A Laboratory Project Manager will be appointed from each laboratory. Laboratory Project Managers will provide analytical support and will be responsible for ensuring that all laboratory analyses meet the project data quality objectives and other specifications required by the ITM/OTM, regional guidance, and the DMMO review process. The Project Managers are as follows:

Project Management and Bioassay Testing:
Mr. Jeffrey Cotsifas
Pacific EcoRisk
2250 Cordelia Road
Fairfield, CA 94534
Phone: (707) 207-7760
Email: cotsifas@pacificecorisk.com

Sediment Chemistry and Conventional Analyses:
Mr. Bob Sterns
Calscience Environmental Laboratories, Inc.
7440 Lincoln Way
Garden Grove, CA 92841
Phone: (714) 894-7501

Vibracore Sampling Vessel Operation:
Mr. Mark Mertz
TEG Oceanographic Services
216 Florence Drive
Santa Cruz, CA 95061
Phone: (831) 684-2749

The contract laboratories are expected to meet the following minimum technical requirements as specified in their negotiated subcontracts with PER:

1. Adherence to the methods outlined in the SAP, including those methods referenced for each analytical procedure, as per /OTM, PN-01-01, and DMMO requirements;
2. Deliver electronic data files as specified;
3. Meet all reporting requirements;
4. Implement and comply with QA/QC procedures required by ITM/OTM and DMMO guidelines;
5. Allow PER to perform laboratory and data audits; and
6. Meet turnaround times for deliverables.

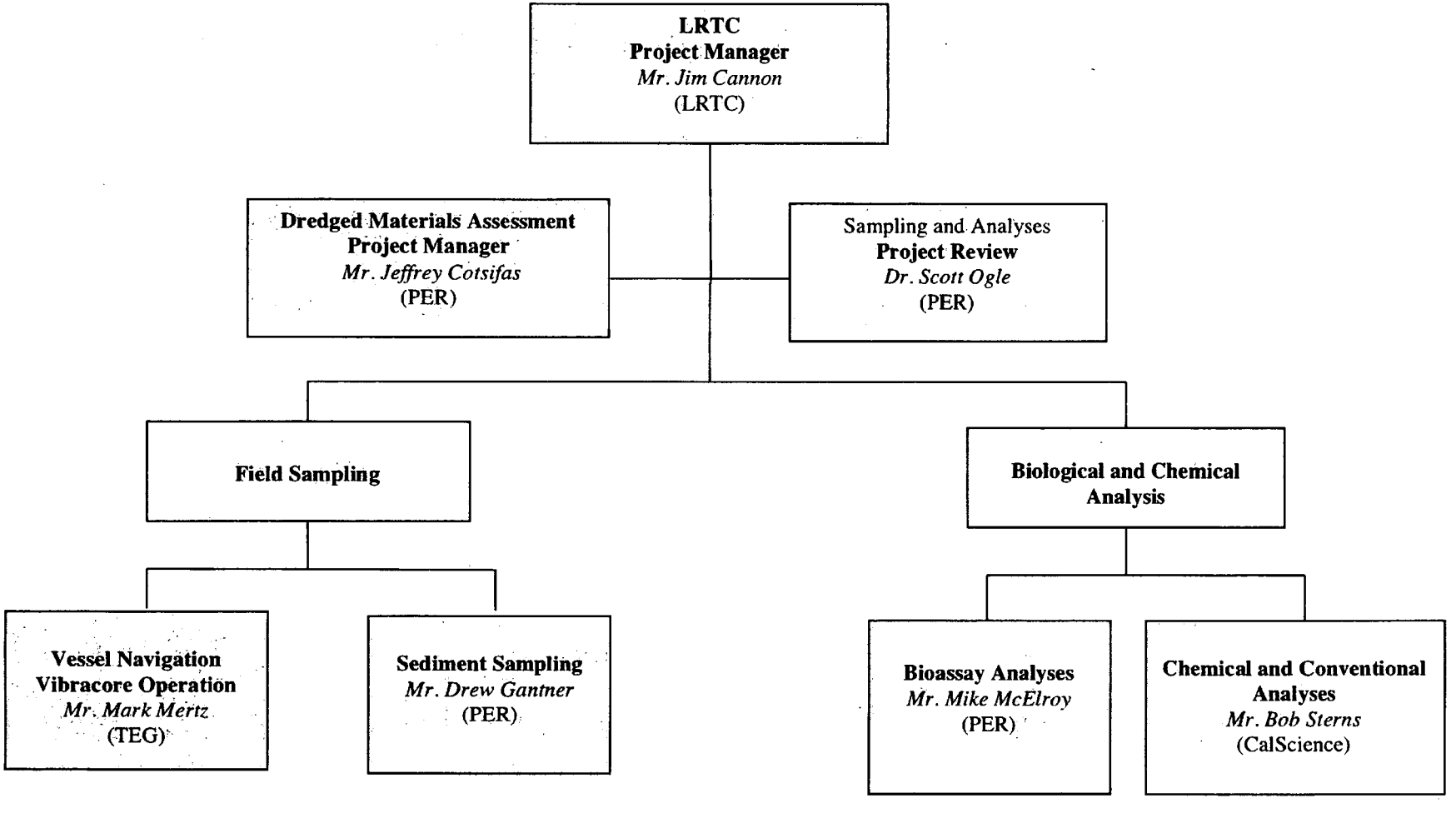


Figure 2-1. Project Organizational Chart

3. REVIEW OF EXISTING DATA

A site history of the LRTC Berth A uses and a description of any spills or discharges within the vicinity of the LRTC Berth A are presented in Section 3.1. Existing information on suitability determinations and chemical, physical, and biological characterizations of the sediment at the LRTC Berth A are summarized in Sections 3.2 and 3.3.

3.1 Site History

The LRTC Loading Terminal is located in the Richmond Inner Harbor in Richmond, CA. The eastern end of the facility is bordered by Pacific Atlantic Terminal. Manson Construction is located northwest of the terminal facility; Kinder Morgan and ConocoPhillips are located directly across the channel.

A portion of the LRTC property is located on what is currently known as the United Heckathorn Superfund site. The site is in an industrial area dominated by petroleum and shipping terminals. From 1947 to 1966, several operators, including the R.J. Prentiss Company, Heckathorn and Company, United Heckathorn, United Chemetrics, and Chemwest Incorporated (collectively referred to as "United Heckathorn"), used the site to formulate and package pesticides. No chemicals were manufactured on site. Although many pesticides were handled by United Heckathorn, DDT accounted for approximately 95% of its operations. United Heckathorn went bankrupt and vacated the site in 1966. Between 1966 and 1970, the United Heckathorn buildings were demolished and cleared from the site. In the 1970s, the site was used primarily for bulk storage. LRTC purchased the property in 1981 and currently operates a bulk shipping facility at the site (USEPA 2002a). The USEPA performed in-water remediation activities at the United Heckathorn Superfund Site in 1996-1997 for which approximately 105,000 yds^3 of DDT and dieldrin contaminated sediment were dredged from the Lauritzen Channel (Figure 1-3) and disposed at a hazardous waste facility. Post-remediation studies performed by the USEPA have indicated that DDT and dieldrin are still present in elevated concentrations within the Lauritzen Channel, and future remediation activities are planned.

3.1.1 Storm Drain, Spills and Discharges

To LRTC's knowledge, there have been no spills or other environmental events on their property that would materially change the quality of the Berth A sediments. All storm drains enter into a canal north of Berth A; there are no outfalls located in the near vicinity of Berth A. The LRTC storm drains are regulated by the RWQCB under a NPDES permit; all discharges from these drains have met NPDES permit requirements.

3.2 Review of DMMO Suitability Determinations and Recent Testing History

Testing results for previous maintenance dredging events performed at this facility prior to 2001 were not available. Under a previous permit (USACE 24314S), approximately 7,500 yds^3 of

dredged material removed from Berth A was determined suitable for placement at the Port of Richmond Shipyard #3 and used as sub-base for a new parking lot.

Under previous permits or certification from each of the DMMO Agencies, maintenance dredging has been performed at LRTC Berth A and the adjacent Pacific Atlantic (formally Shore) Terminal berth; due to elevated total DDT levels, this material was placed in deep-cells at the MWP. The results of this testing performed in 2005 (PER 2006a, 2006b, 2006c, 2006d) are presented below in Sections 3.2.1 and 3.2.2. The results of testing performed in 2008 (PER 2009) are presented below in Section 3.2.3.

Under current permits, maintenance dredging was performed at in 2009. As observed in previous investigations, elevated total DDT levels were identified; these sediments were dredged and re-handled at the Port of Oakland's Berth 10 facility with subsequent transport to the Potrero Hills landfill in Fairfield, CA.

Tier I determinations were made for minor dredging performed in 2010 and 2011; sediments from these dredge episodes were placed onsite at the LRTC temporary re-handling facility prior to transport and disposal at the Potrero Hills landfill.

Relevant suitability determinations for the LRTC Berth A made by either the DMMO or its participating agencies are summarized in Table 3-1. Data sources for this review include:

- PER 2006a. Characterization of Levin-Richmond Terminal Sediments: Results of Dredge Materials Sampling and Analysis.
- PER 2006b. Characterization of Levin-Richmond Terminal Site LRT-S01 Sediment Core Samples for Total DDT.
- PER 2006c. Characterization of Shore Terminal Sediments: Results of Dredge Materials Sampling and Analysis.
- PER 2006d. Characterization of Shore Terminal Site LRT-S02 Sediment Core Samples for Total DDT.
- PER 2009. Sediment Characterization Sampling and Analysis Results for the Levin-Richmond Terminal Corporation Berth A: Maintenance Dredging Program Episode 1.
- PER 2010. Levin-Richmond Terminal Corporation Berth A Episode 1 Maintenance Dredging Tier I Request for "Clean-up" of Approximately 814 Cubic Yards of Sediment.
- PER 2011. Levin-Richmond Terminal Corporation Berth A Episode 2 Maintenance Dredging Tier I Decision Request for Approximately 675 Cubic Yards of Sediment.

Table 3-1. DMMO Maintenance Dredging Sediment Suitability Determinations.

Year	Testing	Outcome
2001	ITM (analytical chemistry only)	Suitable for placement at upland site
2005	Full ITM	Suitable for placement at MWP or landfill
2009	ITM/OTM (analytical chemistry only)	Suitable for placement at MWP or landfill
2010	Tier I Decision	Suitable for placement at landfill
2011	Tier I Decision	Suitable for placement at landfill

3.2.1 Recent Testing for Levin-Richmond Terminal Berth A - October 2005

This sediment was ~44% total solids and contained 1.72% TOC, which is typical for San Francisco Bay. Grain size analyses indicated that the sediment was 76.2% silts and clays, 18.2% sand, and 3.3% gravel.

All metal analytes were generally similar to ambient bay concentrations (SFRWQCB, 1998). The total organotin concentration was 45.7 μg/kg. The total PAH concentration was 4,664 μg/kg. Total DDT concentrations ranged from 274-462 μg/kg with dieldrin and heptachlor epoxide measured at 8.7 and 1.7 μg/kg, respectively; all other organochlorine pesticides and PCB Aroclors were below their respective detection limits.

Biological testing indicated that there was no toxicity to amphipods or polychaetes; all elutriate samples were below the elutriate suitability concentration (ESC) for sediment disposal at in-bay sites.

Based on the above testing results, the DMMO determined that all of the sediments were suitable for placement at the MWP's deep cells; summary tables of the analytical chemistry and bioassay results for each testing event are presented in Appendix B.

3.2.2 Recent Testing for Pacific Atlantic (formerly Shore) Terminal - October 2005

This sediment was ~45% total solids and contained 1.14% TOC, which is typical for San Francisco Bay. Grain size analyses indicated that the sediment was 89.1% silts and clays, 13.3% sand, and 0% gravel.

All metal analytes were generally similar to ambient bay concentrations (SFRWQCB, 1998). The total organotin concentration was 29 μg/kg. The total PAH concentration was 110.4 μg/kg. Total DDT concentrations ranged from 140-290 μg/kg with dieldrin, endosulfan II, endrin ketone, and heptachlor epoxide measured at 3.4, 3.1, 1.4 and 1.2 μg/kg, respectively; all other organochlorine pesticides and PCB Aroclors were below their respective detection limits.

Biological testing indicated that there was no toxicity to amphipods or polychaetes; all elutriate samples were below the ESC for sediment disposal at in-bay sites.

Based on the above testing results, the DMMO determined that all of the sediments were suitable for disposal at the MWP's deep cells; summary tables of the analytical chemistry and bioassay results for each testing event are presented in Appendix C.

3.2.3 Recent Testing for Levin-Richmond Terminal Berth A - October 2009

This sediments were ~35-47% total solids and contained 1.12 to 1.64% TOC, which is typical for San Francisco Bay. Grain size analyses indicated that the sediment ranged from 35-47 % silts and clays, 18-46% sand, and 3.9-46.4% gravel.

All metal analytes were generally similar to ambient bay concentrations (SFRWQCB, 1998). The total PAH concentrations ranged from 396 to 4,350 μg/kg. PCB Aroclor concentrations ranged from 44.8-448 μg/kg. Total DDT concentrations ranged from 20.2-532 μg/kg with dieldrin concentrations ranging from 1.0-33.5 μg/kg; all other organochlorine pesticides and organotins were below their respective detection limits.

Based on the above testing results, the DMMO determined that all of the sediments were suitable for placement at the MWP's deep cells or upland landfill; summary tables of the analytical chemistry results are presented in Appendix C.

4. SAMPLING PROGRAM: SEDIMENT COLLECTION AND HANDLING

A total of 8 sediment cores will be collected from within the LRTC Berth A (Figure 1-4); all sediment cores will be collected using a vibra-corer. Four sediment cores will be collected directly in front of the wharf to support advanced maintenance dredging of a trench along the face of the wharf. Each of the sediment cores will be collected to the project depth of -45.0 ft MLLW (the permitted depth + 1 ft over depth) plus an additional 0.5 ft for the characterization of the "Z" layer (the expected post-dredging mudline); the total cored depth will be -46.5 ft MLLW. An additional 4 sediment cores will be collected throughout the remaining berth area. Each of the sediment cores will be collected to the project depth of -42.0 ft MLLW (the permitted depth + 1 ft over depth) plus an additional 0.5 ft for the characterization of the "Z" layer; the total cored depth will be -42.5 ft MLLW. Prior to any homogenization of the individual core samples, the "Z" layers will be removed and processed separately.

4.1 Sampling Platform

TEG will provide the sampling vessel and all equipment necessary for the safe operation of the boat to support sampling operations. The sampling vessel is a 35-ft long trawler vessel with a 4-ton belt hydraulic crane for deploying and retrieving sampling equipment; operation of the sampling vessel will be the responsibility of Mr. Mark Mertz. The vessel is powered by twin V12 diesel engines, has an AC/DC electrical system and approximately 35 x 20 ft^2 of clear aft deck workspace for processing samples. The vessel conforms to U.S. Coast Guard safety standards.

Collection of sediment cores will be performed by both TEG and PER Field Scientists. Sediment cores will be collected, physically evaluated, and stored in appropriate sample containers on-board the vessel.

4.2 Navigation and Vertical Control

Location control will be the responsibility of the boat captain and will be accomplished using a global positioning system (GPS) that uses U.S. Government Wide Angle Augmentation System (WAAS) differential correction data was used to identify each sampling location. The navigation system will be calibrated to a known survey monument in the project area, and will be used to guide the vessel to predetermined core sample locations and to identify the exact sampling location where the corer strikes the bottom. The required accuracy for horizontal positioning is ± 3 m.

Upon locating the sampling position, station depth will be measured using an on-board calibrated fathometer or a lead line, and tidal elevation will determined relative to harbor datum MLLW. The tidal elevation will be subtracted from the measured depth to determine the sediment surface elevation relative to MLLW. All vertical elevations will be reported to the nearest foot relative to zero (0) ft MLLW, harbor datum.

In the event that the GPS is not functioning properly because of local interference, station locations will be positioned using a laser range finder to record the perpendicular distance from at least two stationary markers located within the area. Interference with GPS is not expected to be a problem at this location.

4.3 Station Locations

The objective of the sampling station selection and the subsequent compositing design is to provide samples that represent, as accurately as possible, the physical, chemical, and toxicological characteristics of the sediments to be dredged. Results of the most recent bathymetric survey were used to assist in choosing core sample stations (Figure 1-4). Sampling locations were chosen in areas that were representative in depth of the surface sediment above the proposed dredging depth at spatial intervals to provide appropriate general coverage.

4.4 Collection of Sediment Core Samples

The sediment core sampling procedure is summarized in this section. Greater detail is provided in the Standard Operating Procedure (SOP) for sediment core collection (Appendix E).

All samples will be collected using an appropriate coring device. All cores will be collected to the project depth (Table 4-1) plus over-depth, or refusal. For each core, an additional 0.5 ft will be collected immediately below the 'project depth plus over-depth' and designated the "Z-layer." Upon completion of core penetration at a station, the position will be recorded and the sampler recovered.

Mud bioaccum testing: Z layer?

Once the corer is on deck, the sediment core will be extracted from the corer barrel. The core will be examined to determine compliance with acceptability criteria as follows:

1. The core penetrated and retained material to project depth, or to refusal;
2. The cored material does not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube; and
3. There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube, resulting in incomplete core collection.

If core acceptance criteria are not achieved, the core will be rejected and the procedure repeated until acceptance criteria are met. If 3 repeated attempts within 25-50 ft in either direction of the proposed location do not yield a core that meets the appropriate acceptance criteria, the Sampling and Analysis Project Manager or field lead will select an alternate station within the dredging footprint of similar representability.

Table 4-1. Typical LRTC Berth A Sampling Station Locations and Estimated Core Depths.

Area	Dredge Unit	SAMPLE ID	Latitude (decimal-deg)	Longitude (decimal-deg)	Mudline Elevation (ft MLLW)	Proposed Project Depth + Over-Depth (ft MLLW)	Z-Layer (ft)	Total Depth Cored (ft MLLW)	Estimated Core Length (ft)
Berth A Trench	DU1	LRTC-DU1-01	TBD	TBD	-39.8	-46	0.5	-46.5	6.7
		LRTC-DU1-02	TBD	TBD	-37.5	-46	0.5	-46.5	9.0
		LRTC-DU1-03	TBD	TBD	-39.3	-46	0.5	-46.5	7.2
		LRTC-DU1-04	TBD	TBD	-39.5	-46	0.5	-46.5	7.0
Berth A	DU2	LRTC-DU2-01	TBD	TBD	-40.5	-42	0.5	-42.5	2.5
		LRTC-DU2-02	TBD	TBD	-40.3	-42	0.5	-42.5	2.2
		LRTC-DU2-03	TBD	TBD	-40.7	-42	0.5	-42.5	1.8
		LRTC-DU2-04	TBD	TBD	-39.4	-42	0.5	-42.5	3.1

TBD – to be determined.

4.4.1 Collection of Site Water

Ambient surface water will be collected from within the permitted dredge limits as a contingency for use in preparing the sediment elutriates for biological testing. Briefly, site water will be collected from approximately 3 ft below the surface using a battery-operated peristaltic pump fitted with tygon tubing. Site water will be "pre-pumped" through the tubing for approximately 3 minutes before the sample is collected. Water will then be pumped into a 20-L polypropylene carboy, with the carboy being pre-rinsed 3 times with site water before the site water sample is collected. After the site water samples are collected, the carboys will be sealed, labeled, and stored on ice, until delivered to the bioassay laboratory.

4.5 On-Board Sample Processing and Labeling

Each core will be sectioned to separate the maintenance depth sediment from the Z-layer. The resultant individual core sections will be extruded and placed into food-grade polyethylene bags on board the sampling vessel. Physical characteristics of each core will be noted on the individual sediment core collection log. Aboard the vessel, samples will be temporarily stored on ice (or frozen "blue ice") within insulated coolers.

4.5.1 Station and Sample Identification

Each individual sediment core and composite sediment sample will be assigned a unique alphanumeric identifier using the format described below:

- The first 4 characters will identify the area e.g., LRTC = Levin-Richmond Terminal Corporation,
- The next 3 characters will identify the dredge unit,
- The last two to three characters will be used to identify:
  1) the coring location, and
  2) the sequence of collection from that particular site.

  For coring locations and respective individual samples, these two characters will be 01 and 02.

Using this approach, the individual core samples for LRTC-DU1will be identified as:

LRTC-DU1-01,
LRTC-DU1 -02,
LRTC-DU1-03, and
LRTC-DU1-04.

Using this approach, the individual the Z-layer samples for LRTC-DU1Z will be identified as:

LRTC-DU1-01Z,
LRTC-DU1-02Z,
LRTC-DU1-03Z, and
LRTC-DU1-04Z

4.6 Field Equipment Decontamination Procedure

The deck of the vessel will be rinsed clean with site water between stations. All sampling equipment coming in contact with collected sediments will be decontaminated between stations using the following procedures:

1. Rinse with site water and wash with scrub brush until free of sediment;
2. Wash with phosphate-free biodegradable soap solution; and
3. Rinse with site water taken from 3 ft below the surface.

Any sampling equipment that cannot be properly cleaned will not be used for subsequent sampling activity.

Acid- or solvent-washing will not be used in the field due to safety considerations and problems associated with rinsate disposal. Residue of acids and solvents on sampling equipment may affect sample integrity for chemical testing. The use of acids or organic solvents on the deck of a vessel may pose a safety hazard to the crew.

4.6.1 Waste Disposal

All sediment remaining on deck after sampling will be washed overboard at the collection site prior to moving to the next sampling station. All disposable sampling materials and personnel protective equipment used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-duty garbage bags or other appropriate containers. Disposable supplies will be removed from the vessel by sampling personnel and placed in a normal refuse container for disposal as solid waste.

4.7 Field Data Recording

The Sampling and Analysis Project Manager, or his designee, will maintain a field logbook. The field logbook will provide a description of all sampling activities (including documentation of all samples collected for analysis), sampling personnel, weather conditions, and a record of all modifications to the procedures and plans identified in this SAP. The field logbook is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period.

Core collection log sheets will be completed for each sediment core. In addition to standard entries of personnel, date, and time, the log sheet will also include information regarding station coordinates, core penetration, and physical characteristics of the sediment such as texture, color, odor, stratification, and sheens.

4.8 Laboratory Sample Processing/Compositing Plan

Compositing of individual cores will be performed at the PER laboratory. The sediment from each individual core will be individually homogenized in a stainless-steel bowl or high-density polyethylene (HDPE) container. A 500-mL sub-sample of the homogenized sediment from each individual core will be archived to allow for additional chemical analyses, if necessary (archived samples will be stored frozen at –20 ± 10°C for up to one [1] year after sample collection). Representative portions of the remaining homogenized sediment from each of the cores for each dredge unit will be proportionately combined to form homogenized composite samples (designated DU1 and DU2). A 500-mL aliquot of the homogenized site composite will be archived as described above. The Z-layer samples will be processed in a similar fashion and archived for analysis, if needed.

Appropriate volumes of each of the site composite samples will be collected into sample containers for shipment to analytical laboratories for physical and chemical analyses. Sample labels will be filled out with an indelible-ink pen and affixed to the sample containers. Each label will contain the project number, sample identification number, preservation technique, requested analyses, date and time of collection and preparation, and initials of the person preparing the sample. To protect the information on the sample labels, clear tape will be placed around the labeled sample containers. The sample containers will then be placed into a sample freezer and frozen until shipped, with the exception of sediment samples slated for grain size analysis, which will be stored at 0-6°C.

Appropriate volumes of the remaining homogenized site composite sediments will be stored at 0-6°C for possible subsequent biological testing, as appropriate. The remaining sediments from each of the individual cores will also be stored at 0-6°C.

4.9 Sample Shipping

Prior to shipping to the analytical laboratory, sample containers will be wrapped in bubble wrap and securely packed inside a cooler with ice packs or crushed ice. A temperature blank will be included in each cooler. The original signed chain-of-custody (COC) forms will be placed in a sealed plastic bag and taped to the inside lid of the cooler. Appropriate packaging tape will be wrapped completely around the cooler. A *This Side Up* arrow label will be attached on each side of the cooler, a *Glass-Handle with Care* label will be attached to the top of the cooler, and the cooler will be sealed with custody seals on both the front and the back lid seams.

Sediment samples will be shipped by overnight delivery. The Laboratory Project Manager at each laboratory will ensure that appropriate COC protocol is followed. The respective laboratory QA Officers will ensure that the temperature of the temperature blank included in each cooler is measured and recorded, and that any coolers that do not contain ice packs or are not sufficiently cold upon receipt are specifically noted.

The sub-contracting analytical laboratories will not dispose of any samples for this project until notified by PER in writing.

4.9.1 Chain-of-Custody (COC) Protocol

COC procedures will be followed for all samples throughout the collection, handling, and analyses activities. The Sampling and Analysis Project Manager, or a designee, will be responsible for all sample tracking and COC procedures. This person will be responsible for final sample inventory, maintenance of sample custody documentation, and completion of COC forms prior to transferring samples to the analytical laboratory. A COC form will accompany each cooler of samples to the respective analytical laboratories. Each person who has custody of the samples will sign the COC form; a copy of the COC form will be retained in the project file.

Each Laboratory Project Manager will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC forms. The Laboratory Project Manager will contact the Sampling and Analysis Project Manager, or designee, immediately if discrepancies between the COC forms and the sample shipment are discovered.

5. LABORATORY ANALYSES

Chemical and conventional analyses will be performed on the composite samples to determine whether sediments may be a candidate for placement at SF-DODS. If the results of chemical analysis indicate that sediments may be SUAD, the required biological analyses to determine suitability for placement at SF-DODS will be performed. Samples will be archived for contingency analyses that might be needed to provide for any landfill or MWP deep cell placement site-specific requirements (i.e., waste extraction testing [WET]), should sediments be determined NUAD at SF-DODS. The full suite of chemical and biological testing used to assess sediment suitability for these disposal options are presented in Sections 5.1-5.3. The proposed testing program is presented below in Table 5-1.

Table 5-1. Proposed Testing Program for LRTC Berth A Sediments.

Sample Area	Dredge Unit	Analytical Chemistry	Toxicity Testing	Bioaccumulation Testing
Berth A Trench	DU1	x	x[A]	x[A]
Berth A	DU2	x	x[A]	x[A]

A – Performance of this testing will be determined after evaluation of analytical chemistry data.

5.1 Chemical and Conventional Analyses

All sediment and tissue chemical and conventional analyses will be conducted in accordance with USACE/EPA guidelines (USACE/EPA 1991, 1998). The methods and targeted method reporting limits (MRL) for analyses of bulk sediment, biological tissue, and sediment elutriate samples are provided in Table 5-2. All sediment analytical results will be presented on a dry weight basis (e.g., mg/kg or μg/kg, dry wt). All tissue analytical results will be presented on a wet weight basis (e.g., mg/kg or μg/kg, wet wt). Matrix spikes and sample duplicate analyses will be performed on the site samples. All samples will be maintained according to the appropriate holding times and temperatures for each analysis (presented in Appendix D).

Need individual core chem along wart face.
Test individual 2-layers
May need bioaccum testing on 2-layer if worse than

Table 5-2. Analytical Chemistry Testing Program: Sediment and Tissue Standard List of Analytes, Methods, and Targeted Reporting Limits.

Analyte	Method Used	SAP Targeted MRL
Metals		
Arsenic	EPA 6020	2 mg/kg
Cadmium	EPA 6020	0.3 mg/kg
Chromium	EPA 6020	5 mg/kg
Copper	EPA 6020	5 mg/kg
Lead	EPA 6020	5 mg/kg
Mercury	EPA 7471A	0.02 mg/kg
Nickel	EPA 6020	5 mg/kg
Selenium	EPA 6020	0.1 mg/kg
Silver	EPA 6020	0.2 mg/kg
Zinc	EPA 6020	1 mg/kg
Pesticides		
Aldrin	EPA 8081B	2 µg/kg
a-*BHC*	EPA 8081B	2 µg/kg
b-BHC	EPA 8081B	2 µg/kg
g-BHC (Lindane)	EPA 8081B	2 µg/kg
d-BHC	EPA 8081B	2 µg/kg
Chlordane	EPA 8081B	20 µg/kg
2,4'-DDD	EPA 8081B	2 µg/kg
2,4'-DDE	EPA 8081B	2 µg/kg
2,4'-DDT	EPA 8081B	2 µg/kg
4,4'-DDD	EPA 8081B	2 µg/kg
4,4'-DDE	EPA 8081B	2 µg/kg
4,4'-DDT	EPA 8081B	2 µg/kg
Total DDT	EPA 8081B	2 µg/kg
Dieldrin	EPA 8081B	2 µg/kg
Endosulfan I	EPA 8081B	2 µg/kg
Endosulfan II	EPA 8081B	2 µg/kg
Endosulfan sulfate	EPA 8081B	2 µg/kg
Endrin	EPA 8081B	2 µg/kg
Endrin aldehyde	EPA 8081B	2 µg/kg
Heptachlor	EPA 8081B	2 µg/kg
Heptachlor epoxide	EPA 8081B	2 µg/kg
Toxaphene	EPA 8081B	20 µg/kg
Butyltins		
Mono-butyltin	Krone 1989	10 µg/kg
Di-butyltin	Krone 1989	10 µg/kg
Tri-butyltin	Krone 1989	10 µg/kg
Tetra-butyltin	Krone 1989	10 µg/kg
PAHs (RMP 25)		
Acenaphthene	EPA 8270C	20 µg/kg
Acenaphthylene	EPA 8270C	20 µg/kg
Anthracene	EPA 8270C	20 µg/kg
Benz(a)anthracene	EPA 8270C	20 µg/kg
Benzo(a)pyrene	EPA 8270C	20 µg/kg
Benzo(e)pyrene	EPA 8270C	20 µg/kg
Benzo(b)fluoranthene	EPA 8270C	20 µg/kg
Benzo(g,h,i)perylene	EPA 8270C	20 µg/kg
Benzo(k)fluoranthene	EPA 8270C	20 µg/kg

Table 5-2. *(cont.)* Analytical Chemistry Testing Program: Sediment and Tissue Standard List of Analytes, Methods, and Targeted Reporting Limits.

Analyte	Method Used	SAP Targeted MRL
Biphenyl	EPA 8270C	20 µg/kg
Chrysene	EPA 8270C	20 µg/kg
Dibenz(a,h)anthracene	EPA 8270C	20 µg/kg
Dibenzothiophene	EPA 8270C	20 µg/kg
Dimethylnaphthalene, 2,6-	EPA 8270C	20 µg/kg
Fluoranthene	EPA 8270C	20 µg/kg
Fluorene	EPA 8270C	20 µg/kg
Indeno(1,2,3-cd)pyrene	EPA 8270C	20 µg/kg
Methylnaphthalene, 1-	EPA 8270C	20 µg/kg
Methylnaphthalene, 2-	EPA 8270C	20 µg/kg
Methylphenanthrene, 1-	EPA 8270C	20 µg/kg
Naphthalene	EPA 8270C	20 µg/kg
Perylene	EPA 8270C	20 µg/kg
Phenanthrene	EPA 8270C	20 µg/kg
Pyrene	EPA 8270C	20 µg/kg
Trimethylnaphthalene, 2,3,5-	EPA 8270C	20 µg/kg
PCBs (RMP 40) PCB-8, PCB-18, PCB-28, PCB-31, PCB-33, PCB-44, PCB-49, PCB-52, PCB-56, PCB-60, PCB-66, PCB-70, PCB-74, PCB-87, PCB-95, PCB-97, PCB-99, PCB-101, PCB-105, PCB-110, PCB-118, PCB-128, PCB-132, PCB-138, PCB-141, PCB-149, PCB-151, PCB-153, PCB-156, PCB-158, 170, PCB-174, PCB-177, PCB-180, PCB-183, PCB-187, PCB-194, PCB-195, PCB-201, PCB-203.	EPA 8270C-SIM	0.5 µg/kg
Dioxins (Total TCDD TEQ)	EPA 8290	1 ng/kg
Grain Size	ASTM 1992	±0.1%
Total Solids	EPA 160.3	±0.1%
Total Organic Carbon (TOC)	EPA 415.1	±0.1%
Total Solids (Tissue)	Freeze Dry	±0.1%
Lipids	NOAA	±0.1%

NOTES: µg/kg – microgram/kilogram PAH - polycyclic aromatic hydrocarbons
mg/kg – milligram/kilogram PCB - polychlorinated biphenyls

5.2 Biological Testing

If the analytical chemistry results indicate that the sediment may be SUAD at SF-DODS, toxicity tests will be conducted (according to DMMO regional guidance and appropriate test protocol [i.e., ASTM Methods]) to determine whether anthropogenic contaminants of concern are present at concentrations that are toxic to biota, and whether removal of the sediment from the site and subsequent disposal at an unconfined aquatic disposal site poses a risk of toxicity to resident organisms. Benthic (whole sediment) and water column (sediment elutriate) toxicity tests will be conducted for each composite sediment. In addition, benthic toxicity tests will be performed on the test organisms' "home" sediments or alternative appropriate Control sediments.

The methods used in conducting these evaluations shall follow established guidelines:

- ASTM Method E1367-99. Standard guide for conducting 10-day static toxicity tests with marine and estuarine amphipods (ASTM 2008);
- ASTM Method E724-98. Standard guide for conducting static acute toxicity tests starting with embryos of four species of seawater bivalve mollusk. (ASTM 2008);
- ASTM Method E1611-00. Standard guide for conducting sediment tests with marine and estuarine polychaetous annelids. (ASTM 2008);
- Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods (US EPA 1994); and
- ASTM Method 1688-00a. Standard guide for the bioaccumulation of sediment-associated contaminants by benthic invertebrates (ASTM 2003).

Test species selection and test procedures are discussed in the following sections. If the species proposed for testing are not available, or if the DMMO requests testing with different species, an appropriate alternative species will be selected from ITM/OTM Tables 11-1, 11-2, or 12-1. Summaries of test conditions for biological testing are presented in Appendix F.

5.2.1 Source of Natural Seawater

The natural seawater used in these tests will be obtained from the UC Davis Granite Canyon Marine Laboratory, and is characterized as "pristine"; this water will be stored at the PER laboratory in a 3500-gallon insulated HDPE tank at 4°C. This seawater will be 0.45-μm filtered and then adjusted to the desired test salinity (e.g., 30 ppt) via addition of Type 1 lab water (reverse-osmosis, de-ionized water) prior to use in these tests (these diluted natural seawaters are referred to using the adjusted salinity level [e.g., '30 ppt seawater']).

5.2.2 Sediment Porewater Characterization

Prior to the initiation of the sediment tests, the composited, homogenized core section sediments will be removed from refrigerated storage, and each sample will be re-homogenized in a large stainless steel bowl. Aliquots of the re-homogenized core section composite sediments will be centrifuged at 2,500 g for 15 minutes; the resulting supernatant porewaters will be carefully collected and analyzed for routine water quality characteristics.

5.2.3 Benthic Sediment Toxicity Testing

Benthic tests will be conducted to evaluate the potential adverse toxicological impacts of dredged materials on the benthic community. These tests involve exposing organisms to test sediments and comparing the test organism responses with those exposed to the Control/reference sediments/reference site database. The 2 species proposed for benthic testing [the amphipod, *Ampelisca abdita (or Rhepoxynius abronius)*, and the polychaete, *Neanthes arenaceodentata]* exhibit 3 functional characteristics that represent important ecological usages of the benthic habitat: filter feeding, deposit feeding, and burrowing.

These tests will be performed using ASTM methods [i.e., Standard E1367-99 (ASTM 1999a) and Standard E1611-00 (ASTM 2000)] for the amphipods and polychaetes, respectively. Ammonia and sulfide concentrations will be monitored in sediments immediately prior to setting up of the tests. If the ammonia concentrations in the bulk sediment interstitial waters (porewaters) exceed the recommended concentrations of 15 mg/L total ammonia (PN 99-3), or the total sulfide exceeds the calculated target value [<0.56 mg/L at pH 7.5 (Knezovich et al., 1996)], then pre-test water exchanges (purging) will be required in order to reduce the ammonia and/or sulfide concentrations. In addition, if sediment porewater salinity is <25 ppt, salinity adjustment will be performed to bring the porewater salinity to >25 ppt.

If purging is necessary, it will begin immediately and will be applied to all replicates for all treatments including the negative control and reference sediments. Ammonia or sulfides will be purged by manually exchanging the overlying seawater in each test chamber twice daily. Once all total ammonia concentrations are at or below 15 mg/L, and/or total sulfide concentrations are below the calculated target value, the sediment test replicates will be loaded with test organisms and the tests will be initiated. Overlying water ammonia and/or sulfide concentrations will be monitored at test initiation (Day 0) and termination (Day 10). Salinity, pH, and temperature of the overlying water will also be measured at the test initiation and termination so that the un-ionized ammonia concentration can be calculated.

5.2.3.1 Amphipod Solid-Phase Survival Bioassay - One of the benthic test species will be the tube-dwelling amphipod *A. abdita*, with test organisms being collected from San Francisco Bay or from Narragansett, RI, depending upon availability. All of the amphipods used in the project will be from one location to control for potential geographical genetic variability. Native "home" control sediment will also be obtained from the amphipod collection site.

Amphipod tests will be conducted as 10-day (acute) static exposures, with 5 replicates per treatment. Each replicate will consist of a 1-L glass jar containing ~4 cm of sediment and ~800 mL of clean overlying 30 ppt seawater. The test conditions include exposure at 20 ± 1°C under continuous light. The tests will be initiated with the random allocation of 20 randomly-selected test organisms into each replicate. Water quality parameters, including pH, temperature, dissolved oxygen (D.O.), and salinity, will be measured daily during testing. The tests will be terminated after 10 days exposure. The test endpoint is survival, with the test response for the Site Composite being compared to a reference sediment or reference sediment database for determination of potential impairment.

Reference Toxicant Testing - In order to assess the sensitivity of the amphipods used in these tests to toxic stress, a reference toxicant test will be run concurrently with the whole sediment amphipod test. The *A. abdita* reference toxicant test consists of a 96-hr water-only exposure to KCl with % survival as the test endpoint. The mean test response will be compared to the "typical" response range established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

5.2.3.2 Polychaete Solid-Phase Survival Bioassay - The second benthic test species will be the marine polychaete *N. arenaceodentata*, obtained from an ongoing culture maintained by Aquatic Toxicology Support in Bremerton, WA. Control sediment will be collected from a site free from contamination and of known quality to produce acceptable survival.

Polychaete tests will be conducted as 10-day (acute) static exposures, with 5 replicates per treatment. Each replicate will consist of a 1-L glass beaker containing ~2.5 cm of sediment and ~800 mL of clean overlying 30 ppt seawater. The test conditions include exposure at 20 ± 1°C under a 12L:12D photoperiod. The tests will be initiated with the random allocation of 10 randomly selected test organisms into each replicate. Water quality parameters, including pH, temperature, D.O., and salinity, will be measured daily during testing. The tests will be terminated after 10 days exposure. The test endpoint is survival, with the test response for the Site Composite being compared to a reference sediment or reference sediment database for determination of potential impairment for determination of potential impairment.

Reference Toxicant Testing - In order to assess the sensitivity of the polychaetes used in these tests to toxic stress, a reference toxicant test will be run concurrently with the whole sediment polychaete test. The *N. arenaceodentata* reference toxicant test consists of a 96-hr water-only exposure test using KCl with % survival as the test endpoint. The mean test response will be compared to the "typical" response range established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

5.2.3.3 Statistical Analyses for the Benthic Sediment Toxicity Tests - The Control treatment acceptability criteria for survival is ≥90% survival in the "Home" (or other appropriate Control) sediment treatment for both amphipods and polychaetes. The test organism survival data will be analyzed to determine if there are any statistically significant reductions in survival in the sediment relative to the appropriate reference sediment. All statistical analyses will be performed using CETIS® statistical software (TidePool Scientific, McKinleyville, CA). A toxicologically significant effect in the sediment bioassays is defined as a statistically significant reduction in survival and:

- a >20% reduction in survival for amphipods relative to the reference site; or
- a >10% reduction in survival for polychaetes relative to the reference site.

5.2.4 Sediment Elutriate Water Column Toxicity Testing

Dredged material disposal regulations for unconfined aquatic disposal require water-column evaluations of the sediment elutriate. Sediment elutriate tests will be performed using bivalve (*Mytilus galloprovinciales*) embryos as described in ASTM method E724-98, mysid shrimp (*Americamysis bahia*) as described in EPA/821/R-02/012 (Test Method 2007.0), and the inland silverside (*Menidia beryllina*) as described in EPA/821/R-02/012 (Test Method 2006.0). Any alternative methods used will follow ITM (USEPA/USACE 1991, 1998) guidance.

5.2.4.1 Standard Elutriate Test (SET) Procedures - The elutriate samples will be prepared as per ITM/OTM procedures, mixing a slurry of 1 part sediment to 4 parts site water for 30 minutes at room temperature (~22°C), followed by a 60 minute settling period (post-settling centrifugation may be implemented, if necessary to remove suspended fines). The resulting supernatant is considered 100% elutriate. If the salinity of the site water is ≤28 ppt, the site water will either be adjusted up to a salinity of 30±2 ppt via addition of artificial sea salts prior to use, or clean seawater collected from the UC Davis Granite Canyon Marine Laboratory (Carmel, CA) will be diluted to a salinity of 30±2 ppt via addition of Type 1 lab water for use in the elutriate preparation.

5.2.4.2 Water Column Bivalve Embryo-Larval Development Bioassay - The Control water for this testing will consist of 0.45-μm-filtered clean seawater (from the UC Davis Granite Canyon Marine Laboratory), diluted to ~30 ppt salinity via addition of Type 1 Lab Water. The 100% elutriate and the Control water will be used to prepare additional test solutions at concentrations of 1%, 10%, and 50% elutriate. If ammonia concentrations in the bulk sediment exceed 15 mg/L total ammonia-N, an additional 25% elutriate concentration may be included; this additional concentration has proven useful in the past in differentiating between chemical-related effects and ammonia-related effects. Routine water quality characteristics will be determined for each test solution prior to use in these tests.

There will be 5 replicates for each treatment, each replicate consisting of 10-mL of test solution within a 20-mL glass scintillation vial. The tests will be initiated by the random allocation of 150-300 *M. galloprovinciales* embryos into each test replicate, which will then be placed into a temperature-controlled incubator at 16°C under a 16L:8D photoperiod.

After 48 (±2) hrs exposure, the tests will be terminated, and the contents of each test replicate vial will be preserved via addition of 5% glutaraldehyde. The preserved embryos will be examined microscopically to determine the percentage survival and percentage normal embryo development of the test organisms. The resulting survival and embryo development data are then statistically analyzed and key dose-response LC and EC point estimates determined for each site sediment elutriate using the CETIS® statistical software.

Reference Toxicant Testing - In order to assess the sensitivity of the *M. galloprovinciales* embryos used in these tests to toxicant stress, a reference toxicant test will be performed. The reference toxicant test will be performed similarly to the sediment elutriate tests, except that test solutions will consist of Lab Control water spiked with KCl at concentrations of 0.5, 1, 2, 3, and 4 gm/L. The resulting test response data will be analyzed to determine key dose-response point estimates (e.g., EC_{50}); all statistical analyses will be made using the CETIS® software. The mean test responses will then be compared to the "typical" response ranges established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

5.2.4.3 Water Column *Americamysis bahia* Acute Toxicity Test - The Control water for this testing will consist of 0.45-μm-filtered clean seawater (from the UC Davis Granite Canyon Marine Laboratory), diluted to ~30 ppt salinity via addition of Type 1 lab water. The 100% elutriate and the Control water will be used to prepare test solutions at concentrations of 1%, 10%, and 50% elutriate. If ammonia concentrations in the bulk sediment exceed 15 mg/L total ammonia-N, an additional 25% elutriate concentration may be included; this additional concentration has proven useful in the past in differentiating between chemical-related effects and ammonia-related effects. Routine water quality characteristics will be determined for each test solution prior to use in these tests.

There will be 5 replicates for each treatment, each replicate consisting of 200-mL of test solution within a 600-mL beaker. The tests will be initiated by the random allocation of 10 mysids into each test replicate, which will then be placed into a temperature-controlled room at 20°C under a 16L:8D photoperiod.

Each day, water quality conditions will be determined for one randomly-selected replicate per treatment, and the test replicates are examined to determine the number of surviving organisms, with any dead organisms being removed via pipette. After ~48 hrs, each replicate is fed brine shrimp nauplii.

After 96 (±2) hrs. exposure, the tests are terminated. At test termination, the final water quality conditions are determined for one randomly-selected replicate per treatment, after which each of the test replicates will be examined to determine the number of surviving mysids. The resulting survival data will then be statistically analyzed and key dose-response EC point estimates determined for each site sediment elutriate using the CETIS® statistical software.

Reference Toxicant Testing – In order to assess the sensitivity of the test organisms to toxic stress, a reference toxicant test will be performed concurrently with the elutriate tests. The *A. bahia* reference toxicant test consists of a 96-hr water-only exposure test using KCl with % survival as the test endpoint. The resulting test response data will be analyzed to determine key dose-response point estimates (e.g., EC_{50}); all statistical analyses will be made using the CETIS® software. The mean test responses will then be compared to the "typical" response ranges established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

5.2.4.4 Water Column *Menidia beryllina* Acute Toxicity Test – The Control water for this testing will consist of 0.45-μm-filtered clean seawater (from the UC Davis Granite Canyon Marine Laboratory), diluted to ~30 ppt salinity via addition of Type 1 lab water. The 100% elutriate and the Control water will be used to prepare test solutions at concentrations of 1%, 10%, and 50% elutriate. If ammonia concentrations in the bulk sediment exceed 15 mg/L total ammonia-N, an additional 25% elutriate concentration may be included; this additional concentration has proven useful in the past in differentiating between chemical-related effects

and ammonia-related effects. Routine water quality characteristics will be determined for each test solution prior to use in these tests.

There will be 5 replicates for each treatment, each replicate consisting of 200-mL of test solution within a 600-mL beaker. The tests will be initiated by the random allocation of 10 fish into each test replicate, which will then be placed into a temperature-controlled room at 20°C under a 16L:8D photoperiod.

Each day, water quality conditions will be determined for one randomly-selected replicate per treatment, and the test replicates are examined to determine the number of surviving organisms, with any dead organisms being removed via pipette. After ~48 hrs, each replicate is fed brine shrimp nauplii.

After 96 (±2) hrs. exposure, the tests are terminated. At test termination, the final water quality conditions are determined for one randomly-selected replicate per treatment, after which each of the test replicates will be examined to determine the number of surviving fish. The resulting survival data will then be statistically analyzed and key dose-response EC point estimates determined for each site sediment elutriate using the CETIS® statistical software.

Reference Toxicant Testing – In order to assess the sensitivity of the test organisms to toxic stress, a reference toxicant test will be performed concurrently with the elutriate tests. The *M. beryllina* reference toxicant test consists of a 96-hr water-only exposure test using KCl with % survival as the test endpoint. The resulting test response data will be analyzed to determine key dose-response point estimates (e.g., EC_{50}); all statistical analyses will be made using the CETIS® software. The mean test responses will then be compared to the "typical" response ranges established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

5.2.5 Benthic Sediment Bioaccumulation Testing– Must do per ocean. Want to see clam? (YES – P.4)
In the event that bioaccumulation testing is triggered based on the analytical chemistry results and at the DMMO request, the methods described in this section will be followed.

Bioaccumulation tests are designed to evaluate the potential of benthic organisms to accumulate contaminants from contaminated sediment. Bioaccumulation tests are based on analysis of the organisms' tissues after 10 or 28 days of exposure. The 10-day exposure test is appropriate when the only contaminants of concern are metals; 28-day tests should be used when any contaminants of concern are organic or organometallic.

The two species proposed for benthic bioaccumulation testing are the bivalve, *Macoma nasuta* and the polychaete, *Nereis virens*. These tests will be performed using ASTM method E1688-97a. Upon completion of the testing, the resulting tissue will be submitted to the analytical laboratory for analysis of chemicals of potential concern identified in the sediments. Chemical

analysis of the tissues will be performed using the methods described in Section 5.1 and listed in Table 5-1. All analyses will be reported on a wet weight basis.

5.2.5.1 Bivalve Solid-Phase Bioaccumulation Bioassay Using *Macoma nasuta* – The first benthic bioaccumulation test species will be the marine bivalve *M. nasuta*. Control sediment will collected from a site free from contamination and of known quality to produce acceptable survival.

There will be 5 replicates for each treatment, each replicate consisting of 4 L of sediment placed within a 10 L HD polyethylene tank. Clean seawater (1 μm-filtered seawater from the UC Davis Granite Canyon Marine Laboratory) is carefully poured into each tank so as to minimize disturbance of the sediment. The replicate tanks are then placed into a temperature controlled room under aeration at 14°C.

After 24 hrs equilibration, routine water quality characteristics (pH, D.O., and salinity) are determined for each test replicate at each treatment. Then, 20-25 randomly-selected adult clams are placed into each replicate container. Additional bivalves are also transferred to clean sand (to promote depuration) at this time for determination of T_0 tissue concentrations (these tissues will be harvested after 24 hrs, and the tissues processed and frozen for later analyses, as described below). Each day, for the prescribed test duration, the D.O. of the overlying water is measured in one test replicate for each treatment. Approximately 80% of the overlying water in each replicate is carefully replaced three times per week; immediately after each water change, the D.O. and salinity are measured in one test replicate for each treatment.

After the prescribed test duration, the bivalves are transferred into clean containers containing clean sand to allow the organisms to depurate the test sediment. After this purging process, the organisms are rinsed with clean seawater and the shell length is then measured to the nearest mm. The organisms are then placed into an appropriate size container, and immediately frozen. The frozen clams will then be shipped to the appropriate analytical laboratories for analysis of potential contaminants.

Upon arrival at the analytical laboratory, the soft tissue contents of each bivalve are removed using stainless steel forceps and scalpel, rinsed with de-ionized water and blot-dried, and then weighed to the nearest 0.1 gm. The soft tissue samples from each replicate treatment are composited, homogenized in a stainless steel blender, and placed into pre-cleaned glass vials, which are sealed and labeled for identification and subsequent analysis.

5.2.5.2 Polychaete Solid-Phase Bioaccumulation Bioassay using *Nereis virens* – The second benthic bioaccumulation test species will be the marine polychaete *N. virens*. Control sediment will also be collected from a site free from contamination and of known quality to produce acceptable survival. There will be 5 replicates for each treatment, each replicate consisting of 4 L of sediment placed within a 10 L HD polyethylene tank. Clean seawater (1 um-filtered seawater

from the UC Davis Granite Canyon Marine Laboratory) is carefully poured into each tank so as to minimize disturbance of the sediment. The replicate tanks are then placed into a temperature controlled room under aeration at 12°C.

After 24 hrs equilibration, routine water quality characteristics (pH, D.O., and salinity) are determined for each test replicate at each treatment. Then, 50 randomly-selected polychaetes are placed into each replicate container. Additional polychaetes are also transferred to clean sand (to promote depuration) at this time for determination of T_0 tissue concentrations (these tissues are harvested after 24 hrs, and the tissues processed and frozen for later analyses, as described below). Each day, for the prescribed test duration, the D.O. of the overlying water is measured in one test replicate for each treatment. Approximately 80% of the overlying water in each replicate is carefully replaced three times per week; immediately after each water change, the D.O. and salinity are measured in one test replicate for each treatment.

After the prescribed test duration, the polychaetes are sieved from the sediment, and enumerated to determine the number of surviving organisms (for potential use as an assessment of toxicity), and then transferred into clean containers containing clean sand to allow the organisms to depurate the test sediment. After this purging process, the organisms are rinsed with clean seawater and then placed into an appropriate size container, and immediately frozen. The frozen polychaetes will then be shipped to the appropriate analytical laboratories for analysis of potential contaminants.

Upon arrival at the analytical laboratory, each polychaete is removed using stainless steel forceps and scalpel, rinsed with de-ionized water and blot-dried, and then weighed to the nearest 0.1 gm. The tissue samples from each replicate treatment are composited, homogenized in a stainless steel blender, and placed into pre-cleaned glass vials, which are sealed and labeled for identification and subsequent analysis.

5.3 Quality Assurance (QA) Objectives

Quality assurance procedures to be used for sediment characterization and testing are consistent with methods described in USEPA/USACE (1991, 1995, 1998) and USEPA (1998a, 1998b, 2002). The methods employed in this sediment sampling and characterization program are detailed in standard guides (*e.g.*, Standard Methods, ASTM, USEPA, etc.) and Standard Operating Procedures are maintained in the bioassay and analytical laboratories.

All QA/QC records for the various testing programs are kept on file for review by regulatory personnel.

5.3.1 Chemical and Physical Analyses Quality Assurance

5.3.1.1 Accuracy - Accuracy estimates will be based on analyses of lab blanks, analytical recoveries of matrix spikes of test samples and laboratory control materials, and analysis of certified reference material. Results from spikes and/or reference materials are reported as "percent recovery", determined by comparing the measured analyte concentrations of the Standard Reference Materials, Laboratory Control Materials, or matrix spikes to the "True Value." Percent Recovery will be reported along with the corresponding acceptance ranges. Where possible, surrogate compounds will be spiked into each sample and surrogate percent recovery will be reported along with the corresponding control limits.

Matrix spikes are added prior to processing the sample and carried through the entire analytical procedure. Matrix spike data for both trace metals and organics will be provided at a frequency of one set of duplicate spikes per QA batch.

5.3.1.2 Precision - Precision will be estimated by analyzing duplicate samples and matrix spike duplicate samples. Duplicate analyses are performed on actual site samples. Results from duplicate analyses of the actual test samples may also indicate homogeneity of the sample matrix. Relative percent differences (RPDs) are calculated for all duplicate samples or spikes and are reported along with acceptance ranges (typically 0-30%).

5.3.1.3 Analytical Methods - All sample analyses will be performed using EPA Methods, where applicable (see above for method specification for each analyte group). Daily logs of instrument performance are maintained, including initial and continuing calibration verification.

5.3.2 Biological Testing Quality Assurance

All sediment toxicity tests will incorporate standard toxicity testing QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls (reference toxicant tests), reference sediment samples, replicates, and measurements of water quality during testing.

5.3.2.1 Water and Sediment Handling and Storage - Sediment samples will be maintained at 0-6°C in the dark until they are used in the bioassay testing. All sediments will be held in sealed, labeled sample storage bags. Site water samples will be similarly stored in sealed, labeled containers at 0-6°C. Seawater used in these tests will come from the UC Davis Granite Canyon Marine Laboratory (Carmel, CA), and will be stored on-site at PER in an insulated 3,500 gallon HDPE tank at 0-6°C. Sub-samples designated for long-term storage are archived under the appropriate holding conditions.

5.3.2.2 Source and Condition of Test Organisms - All test organisms will be obtained from reputable suppliers who have provided PER with organisms in the past. Normally, all test organisms are maintained in the laboratory for acclimation to test conditions (exceptions are

bivalves). If mortality in excess of 10% is noted in the holding stock, the animals will be discarded and a new batch ordered.

5.3.2.3 Maintenance of Test Conditions and Corrective Actions - Each of the biological tests has a set of specific test conditions that are defined in the standard testing. For example, water quality measurements will be monitored to ensure that test conditions are within the prescribed limits for each test procedure. The limits for various test condition parameters are noted in the section on the acceptability of each test. If these criteria are not met, the test may be re-run if appropriate.

5.3.2.4 Calibration Procedures and Frequency - Instruments are calibrated daily according to Laboratory SOPs and calibration data are logged and initialed. Calibration logs are monitored weekly to ensure completeness.

5.3.2.5 Reference Toxicant Testing and Data Accuracy and Precision - The accuracy of toxicity tests (e.g., LC_{50} point estimates) are not normally measured in biological testing. Instead, concurrent reference toxicant tests are used to assess accuracy and precision. For instance, acceptable accuracy is defined as a current measured LC_{50} reference toxicant value that is within 2 standard deviations of the current "typical" response range established by previously performed reference toxicant tests. A reference toxicant will be performed concurrently with the testing for each species to establish that the test organisms are responding to toxic stress in a typical fashion.

The precision of toxicity tests is assessed via measures of variability (e.g., coefficient of variation [CV] for a given test treatment). While there are no "acceptability limits" placed on the CV for most test responses, these can be evaluated using "Best Professional Judgment" to characterize whether or not the test response at a given treatment is subject to too much variability for use in a given test.

5.3.2.6 Data Evaluations - Bioassay tests are performed according to accepted protocols and standard test conditions. All test data, data analyses, and other relevant records for each test will be reviewed for accuracy and completeness by the quality control unit. Deviations from the standard testing guides are reported with the final report. If and when such deviations are observed, the test will be evaluated to determine whether it is valid according to the regulatory agency to which it will be submitted. If it is determined to be invalid, the client will be notified and the test re-run.

5.3.2.7 Sample Tracking - Sample COC sheets, sample receipt logs, sample holding, and sample labeling procedures are audited weekly by the quality control unit. Sub-samples designated for long-term storage are archived under the appropriate holding conditions.

5.3.3 Deviations from Protocol

Any deviations from approved SOP's or this SAP will be summarized and qualified with respect to how they may have affected data quality.

6. DATA MANAGEMENT

All subcontract analytical laboratories will provide both hard copy and electronic analytical results. All data will be reviewed by the PER Project Manager to ensure that the data quality objectives for each analysis are met and that both the electronic and hard copy forms of data are accurate. Hard copies of all data reports will be placed in the project files at PER; electronic data reports will be archived on PER's server, and will be available for electronic transfer to client staff and the DMMO, if requested.

7. DATA ANALYSIS AND INTERPRETATION

Data will be analyzed and presented clearly so that suitability for disposal at an unconfined aquatic disposal site such as SF-DODs, or placement at a landfill location or the MWP deep cells can be determined. All analytical data will be reviewed for accuracy prior to reporting; data will be presented in tabular form. The physical and chemical characteristics of sediment samples will be evaluated according to the DMMO review process. Benthic sediment toxicity test results will be compared to the SF-DODS reference site database according to the DMMO review process; water column toxicity test results will be compared to Elutriate Suitability Concentrations (ESC) at the edge of the SF-DODS mixing zone. Benthic bioaccumulation testing will be compared to the SF-DODS reference database according to the DMMO review process.

7.1 Sediment Chemistry and Conventional Data Analyses

Sediment physical and chemical characteristics provide information about chemicals of concern present in the sediment and their potential bioavailability, and about non-chemical factors that could affect toxicity. Data analysis of sediment chemistry and conventional parameters will consist of tabulation and comparison with existing regulatory guidelines (USEPA/USACE 1991, 2011, USACE 2001) as requested by the DMMO. Sediment chemistry results will also be used to identify areas that may require higher resolution analysis (e.g., analysis of sediment material from archived individual cores), and/or to assist in evaluating appropriate disposal options.

7.2 Benthic Toxicity Test Data

ITM/OTM guidance requires that test sediment results be compared with disposal site and/or reference site sediment results or a reference site database (if it is available) to determine the potential impact of whole sediment on benthic organisms at and beyond the boundaries of the disposal site (USEPA/USACE 1998). As detailed in the ITM/OTM, comparative guidelines for acceptance are listed below:

1. If survival is greater in the proposed dredged sediments than in reference site sediment(s) or the reference site sediment database, the proposed dredged sediments are <u>not</u> acutely toxic to benthic organisms.
2. If the reduction in the survival in a test sediment relative to the reference sediment (or relative to the 'reference site database') is ≤20% for amphipods or ≤10% for polychaetes, the test sediments are <u>not</u> acutely toxic to benthic organisms.
3. If the reduction in the survival in a test sediment relative to the reference sediment is >20% for amphipods or >10% for polychaetes, then a statistical analysis must be performed. If the reduction in survival in the test sediment is found to be statistically significant (relative to the reference sediment), then the test sediment is considered to be acutely toxic to benthic organisms. Statistical analyses are not performed when reference site database values are used.

7.3 Water Column (Sediment Elutriate or Liquid Suspended Phase) Toxicity Test Data

Comparative guidelines for interpretation of water column tests, as detailed in the ITM/OTM, are listed below:

1. If survival and normal embryo development in the 100% sediment elutriate treatment is ≥ survival and normal embryo development in the Control (clean seawater) treatment, the dredged material is not predicted to be acutely toxic to water column organisms.
2. If the reduction in survival or normal embryo development in the 100% sediment elutriate relative to the Control treatment is ≤10%, there is no need for statistical analyses and no indication of water column toxicity attributable to the test sediments.
3. If the reduction in survival or normal embryo development in the 100% sediment elutriate relative to the Control treatment is >10%, then further analysis must be performed to determine the magnitude of toxicity. If there is >50% survival or normal embryo development in the 100% elutriate, the LC_{50}/EC_{50} is assumed to be ≥100%. If there is <50% survival or normal embryo development in at least one of the elutriate treatments, then an LC_{50}/EC_{50} should be calculated and compared with existing acceptability standards.

7.3.1 Dilution Model Calculations

The Short Term Fate Model for open water barge and hopper discharges will ultimately be used to model the fate of disposed sediments and determine if the concentrations of chemicals of concern will meet water quality criteria at the edge of the mixing zones for the various San Francisco Bay disposal sites; input parameters, unique to each site, are currently being developed. The DMMO approved dilution model currently used to calculate the concentration of sediment at the edge of the mixing zone uses the results of both grain size analysis (% clay and % silt) and water-column bioassay tests (LC_{50}/EC_{50}) to determine if the concentration of dredge material that is swept away from the barge will result in an exceedance at the edge of the disposal site mixing zone. A sample will exceed water quality criteria if 1% of the calculated LC_{50} or EC_{50} (whichever is more conservative) is lower than the projected suspended phase concentration of the dredge material at the edge of the mixing zone. This model will also be used to evaluate impacts at the SF-DODs disposal site.

7.4 Bioaccumulation Testing

Evaluation of bioaccumulation test data will be consistent with ITM/OTM guidelines and DMMO guidance and will be performed as follows:

1. Test organism tissue contaminant concentrations will be compared to the SF-DODs reference database; if a tissue concentration is less than the database range of concentrations, then no further evaluation was needed. If the tissue concentration is greater than the database range of concentrations, then further assessment will be performed;

2. Tissue contaminant concentrations greater than the SF-DODs reference database will be steady-state corrected using the best available data and then compared to available U.S. Food & Drug Administration (USFDA) action levels. If the test organism tissue concentrations are greater than USFDA action levels, then the dredged material is predicted to result in benthic bioaccumulation of contaminants;
3. Tissue concentrations greater than the SF-DODs reference database, but less than available USFDA action levels or for which no USFDA action level exists, will be compared to tissue concentration "effects" data deemed most relevant to the test species obtained from peer-reviewed literature [from the USACE ERED database (http//wes.army.mil/el/ered/index.html; updated October 2009)];
4. Consistent with ITM/OTM guidance, relevant data for use in developing toxicity reference values (TRVs) will be limited to effects data reported in the ERED database that identify measurable biological effects (e.g., reduced survival, growth, or reproduction). Effects data for behavior, physiological, cellular, respiration, etc., endpoints for which there is insufficient information as to cause-and-effect relationship between these endpoints and adverse effects in the ecosystem will not be included. Furthermore, only whole body tissues burden levels will be used to develop TRV values; organ specific data (i.e., only gonads) will not be used; and
5. If a tissue analyte concentration is less than effects data concentrations, then no further evaluation will be performed for that analyte. If the test organism tissue concentration is greater than effects data concentrations, then the magnitude of the exceedance will evaluated along with an assessment of potential food chain effects.

8. REPORTING AND DELIVERABLES

8.1 Sampling and Analysis Results

PER will prepare a Final Sampling & Analysis Report (SAR) documenting all activities associated with the collection, transportation, handling (e.g. compositing), sample shipment, and chemical and conventional analyses, and biological testing of the sediment samples. All Lab Data Reports received from sub-contracting analytical laboratories will be included as Appendices to the SAR. At a minimum, the following will be included in the SAR:

1. Summary of all field activities, including a description of any deviations from the approved SAP;
2. Locations of sediment sampling stations in latitude and longitude (in degrees and minutes to 3 decimal places). All vertical elevations of mud-line and water surface will be reported to the nearest 0.1 ft relative to MLLW;
3. A project map with actual sampling locations;
4. Analytical data results and QA/QC review; and
5. Summary of comparison of chemical results.

9. REFERENCES

ASTM (1999a) Method E1367-99. Standard Guide for conducting 10-day static toxicity tests with marine and estuarine amphipods. ASTM Standards on Biological Effects and Environmental Fate. American Society for Testing and Materials, Philadelphia, PA.

ASTM (1999b) Method E724-98. Standard Guide for conducting static acute toxicity tests starting with embryos of four species of seawater bivalve mollusk. ASTM Standards on Biological Effects and Environmental Fate. American Society for Testing and Materials, Philadelphia, PA.

ASTM (2000) Method E1611-00. Standard Guide for conducting sediment tests with marine and estuarine polychaetous annelids. ASTM Standards on Biological Effects and Environmental Fate. American Society for Testing and Materials, Philadelphia, PA.

ASTM (2003) Method 1688-00a. Standard Guide for the Bioaccumulation of sediment-associated contaminants by benthic invertebrates. ASTM Standards on Biological Effects and Environmental Fate. American Society for Testing and Materials, Philadelphia, PA.

Knezovich JP, Steichen DJ, Jelinski JA, Anderson SL (1996) Sulfide tolerance of four marine species used to evaluate sediment and pore-water toxicity. Bull. Environ. Contam. Toxicol. 57:450-457. Springer-Verlag, New York, NY.

Krone CA, Brown DW, Burrows DG, Bogar RG, Chan SL, Varanasi U (1989) A method for analysis of butyltin species and the measurements of Butyltins in sediment and English sole livers from Puget Sound. Mar. Environ. Res. 27:1-18.

PER (2006a) Characterization of Levin-Richmond Terminal Sediments: Results of Dredge Materials Sampling and Analysis. Prepared for Cooper White & Cooper, Walnut Creek, CA 94596. Prepared by Pacific EcoRisk, Martinez, CA 94553.

PER (2006b) Characterization of Levin-Richmond Terminal Site LRT-S01 Sediment Core Samples for Total DDT. Prepared for Cooper White & Cooper, Walnut Creek, CA 94596. Prepared by Pacific EcoRisk, Martinez, CA 94553.

PER (2006c) Characterization of Shore Terminal Sediments: Results of Dredge Materials Sampling and Analysis. Prepared for Cooper White & Cooper, Walnut Creek, CA 94596. Prepared by Pacific EcoRisk, Martinez, CA 94553.

PER (2006d) Characterization of Shore Terminal Site LRT-S02 Sediment Core Samples for Total DDT. Prepared for Cooper White & Cooper, Walnut Creek, CA 94596. Prepared by Pacific EcoRisk, Martinez, CA 94553.

PER (2009) Sediment Characterization Sampling and Analysis Results for the Levin-Richmond Terminal Corporation Berth A: Maintenance Dredging Program Episode 1. Prepared for Levin-Richmond Terminal Corporation, Richmond, CA. Prepared by Pacific EcoRisk, Fairfield, CA.

PER (2010) Levin-Richmond Terminal Corporatoin Berth A Episode 1 Maintenance Dredging Tier I Request for "Clean-up" of Approximatly 814 Cubic Yards of Sediment. Prepared for Levin-Richmond Terminal Corporation, Richmond, CA. Prepared by Pacific EcoRisk, Fairfield, CA.

PER (2011) Levin-Richmond Terminal Corporatoin Berth A Episode 2 Maintenance Dredging Tier I Decision Request for Approximatly 675 Cubic Yards of Sediment. Prepared for Levin-Richmond Terminal Corporation, Richmond, CA. Prepared by Pacific EcoRisk, Fairfield, CA.

Plumb RH, Jr (1981) Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report U.S. EPA /CE-81-1, prepared by Great Lakes Laboratory, State University College at Buffalo, Buffalo, NY, for the U.S. Environmental Protection Agency/Corps of Army Engineer Waterways Experiment Station, Vicksburg, MS.

SFRWQCB (1998) Ambient concentrations of toxic chemicals in San Francisco Bay Sediments: Draft Staff Report. San Francisco Regional Water Quality Lab Control Board, Oakland, CA.

USACE (1985) Environmental Effects of Dredging: Technical Notes. US Army Engineer Waterways Experiment Station, Environmental Laboratory. Vicksburg, MS.

USACE (2003) Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities (Testing Manual). Vicksburg, MS.

US EPA/USACE (1991) Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual (Ocean Testing Manual). U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. EPA/503/3-91/001. Office of Water. Washington, DC 20460.

US EPA/USACE (1995) QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Materials Evaluations. U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. EPA/823/B-95/001. Office of Water. Washington, DC. EPA-823-B-95-001. April 1995.

US EPA/USACE (1998) Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual (Inland Testing Manual). U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. EPA/823/B-94/002. Office of Water. Washington, DC 20460.

US EPA (1998a) EPA Requirements for Quality Assurance Project Plans. United States Environmental Protection Agency, Quality Assurance Division, Washington, DC 20460.

US EPA (1998b) EPA Guidance for Quality Assurance Project Plans. United States Environmental Protection Agency, Office of Research and Development, Washington, DC 20460.

US EPA (2002) Methods for Measuring the Acute Toxicity of Effluent and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. United States Environmental Protection Agency, Office of Water, Washington, DC 20460.

Appendix A

Previous Physical, Chemical and Biological Testing Results for the Levin-Richmond Terminal Corporation Berth - Testing Performed in 2005

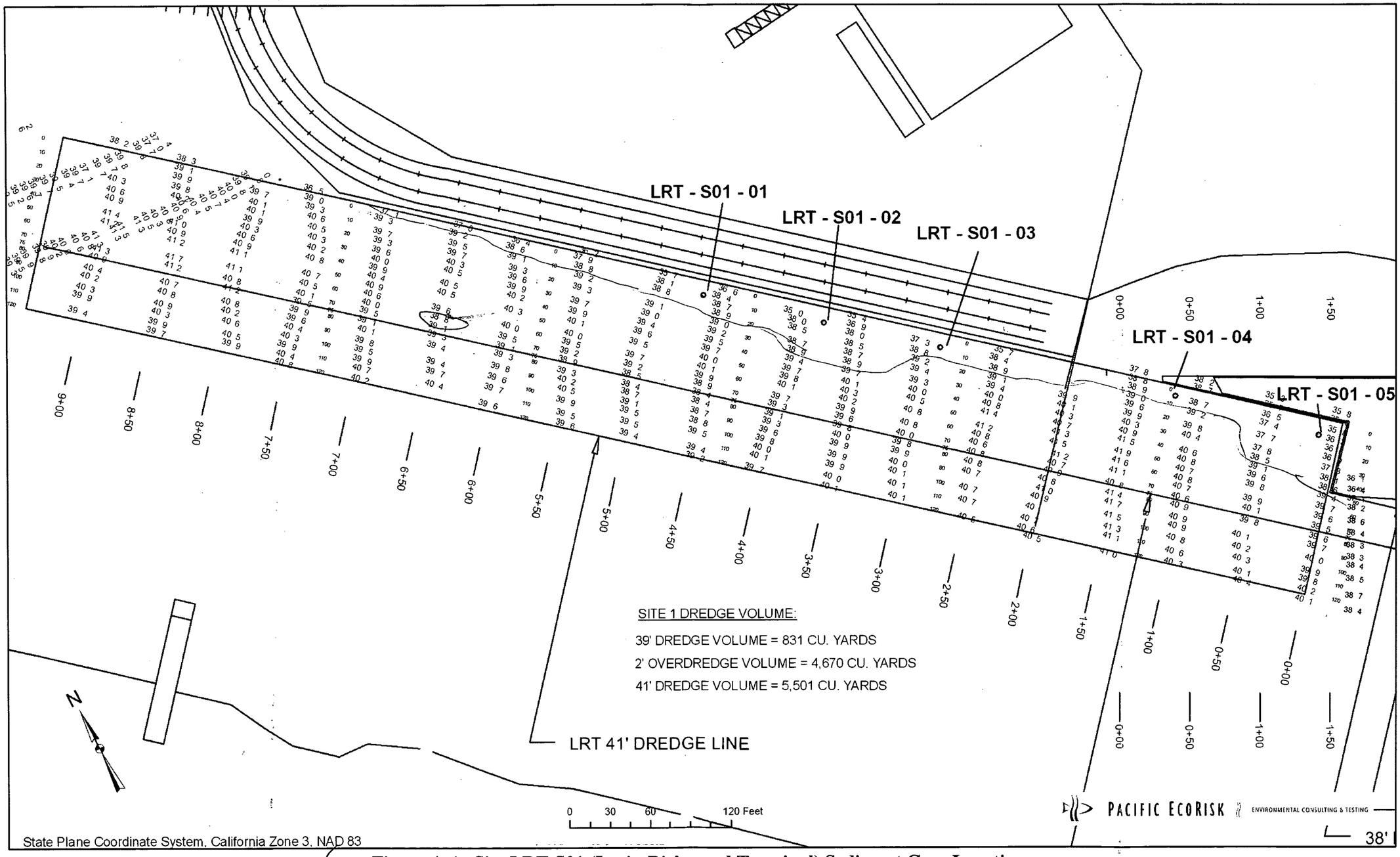


Figure A-1. Site LRT-S01 (Levin-Richmond Terminal) Sediment Core Locations

2005

Table A-1. Results of Grain Size Analyses of Levin-Richmond Sediments.

Analytes	LRT-SO1 COMP	Method Reporting Limit
% Gravel	3.30	0.1
% Sand	18.2	0.1
% Silt	30.1	0.1
% Clay	46.1	0.1

Table A-2. Results of Conventional Analyses of Levin-Richmond Sediments.

Analytes	LRT-SO1 COMP	Method Reporting Limit
Total Solids (% as Dry Wt.)	44.4	0.1
Total Organic Carbon (%)	1.72	0.1

Table A-3. Metals Concentrations (mg/kg, dry wt) of Levin-Richmond Sediments.

Metals	LRT-SO1 COMP	Method Reporting Limit
Arsenic	7.1	0.5
Cadmium	0.44	0.05
Chromium	78.9	1.0
Copper	48.1	0.1
Lead	35.2	0.05
Mercury	0.31	0.02
Nickel	56.6	0.2
Selenium	0.2	0.1
Silver	0.32	0.02
Zinc	95.3	0.5

Table A-4. PAH Concentrations (μg/kg, dry wt) of Levin-Richmond Sediments.

PAHs	LRT-SO1 COMP	Method Reporting Limit
Acenaphthene	26	5.7
Acenaphthylene	46	5.7
Anthracene	160	5.7
Benzo(a)anthracene	350	5.7
Benzo(a)pyrene	530	5.7
Benzo(b)fluoranthene	510	5.7
Benzo(g,h,i)perylene	220	5.7
Benzo(k)fluoranthene	390	5.7
Chrysene	740	5.7
Dibenzo(a,h)anthracene	74	5.7
Dibenzofuran	16	5.7
Fluoranthene	430	5.7
Fluorene	30	5.7
Indeno(1,2,3-cd)pyrene	220	5.7
Methylnaphtalene	18	5.7
Naphthalene	34	5.7
Phenanthrene	140	5.7
Pyrene	730	5.7
Total PAHs	4664	NA

Table A-5. Organochlorine Pesticide Concentrations (µg/kg, dry wt) of Levin-Richmond Sediments.

Organochlorine Pesticides	LRT-SO1 COMP	Method Reporting Limit
Aldrin	<1	1
a-BHC	<1	1
b-BHC	<1.0	1.1
g-BHC (Lindane)	<1	1
d-BHC	<1	1
alpha-Chlordane	<1	1
gamma-Chlordane	<1.7	1.7
Dieldrin	8.7	1
Endosulfan I	<1	1
Endosulfan II	1.3	1
Endosulfan sulfate	<1	1
Endrin	<1	1
Endrin aldehyde	<1	1
Endrin ketone	<1	1
Heptachlor	<1	1
Heptachlor epoxide	1.7	1
Methoxychlor	<1	1
Toxaphene	<84	84
4,4'-DDD	<1	10
4,4'-DDE	28	1
4,4'-DDT	<1	1
Total DDT	28	NA

ABOVE 2011 BT

DOESN'T JIBE!

Table A-6. Total DDT Concentrations (µg/kg, dry wt) of Levin-Richmond LRT-S01 Individual Sediment Core Samples.

Analyte	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-05	Method Reporting Limit
4,4'-DDD	170	190	170	170	260	18
4,4'-DDE	49	52	45	30	51	18
4,4'-DDT	86	220	160	74	73	18
Total DDT	305	462	375	274	384	NA

Table A-7. Organotin Concentrations (µg/kg, dry wt) of Levin-Richmond Sediments.

Organotins	LRT-SO1 COMP	Method Reporting Limit
Monobutyltin	2.7	2.3
Dibutyltin	13	2.3
Tributyltin	30	2.3
Tetrabutyltin	<2.3	2.3
Total Butyltins	45.7	NA

Table A-8. PCB Aroclor Concentrations (µg/kg, dry wt) of Levin-Richmond Sediments.

PCB Aroclors	LRT-SO1 COMP	Method Reporting Limit
Aroclor 1016	<10	10
Aroclor 1221	<20	20
Aroclor 1232	<10	10
Aroclor 1242	<10	10
Aroclor 1248	<10	10
Aroclor 1254	<79	79
Aroclor 1260	<10	10
Total PCBs	<10	NA

Table A-9. *Ampelisca abdita* Survival in the Solid-Phase Test Sediments.

Sediment Site	% Survival in Test Replicates					Overall Mean % Survival
	Rep A	Rep B	Rep C	Rep D	Rep E	
"Home" Lab Control	100	95	95	90	90	**94**
Alcatraz (SF-11)	70	75	80	80	75	**76**
San Pablo (SF-10)	75	100	65	85	65	**78**
LRT-SO1 COMP	95	90	95	75	90	**89**

Table A-10. *Neanthes arenaceodentata* Survival in the Test Sediments.

Sediment Site	% Survival in Test Replicates					Overall Mean % Survival
	Rep A	Rep B	Rep C	Rep D	Rep E	
"Home" Lab Control	100	90	100	100	100	**98**
Alcatraz (SF-11)	100	100	100	100	100	**100**
San Pablo (SF-10)	100	100	100	100	100	**100**
LRT-SO1 COMP	100	100	100	100	90	**98**

Table A-11. Effects of LRT-SO1 COMP Sediment Elutriate on *Mytilus sp.* Embryos.

Elutriate Treatment	Mean % Survival	Mean % Normal Development
Lab Control	93	93
1%	93	90
10%	89	93
25%	95	94
50%	87	86
100%	0	0
LC_{50} or EC_{50} =	66.6% elutriate	73.1% elutriate
Disposal limit met?	Yes	Yes

Appendix B

Previous Physical, Chemical and Biological Testing Results for the Adjacent Pacific Atlantic (formally Shore) Terminal - Testing Performed in 2005

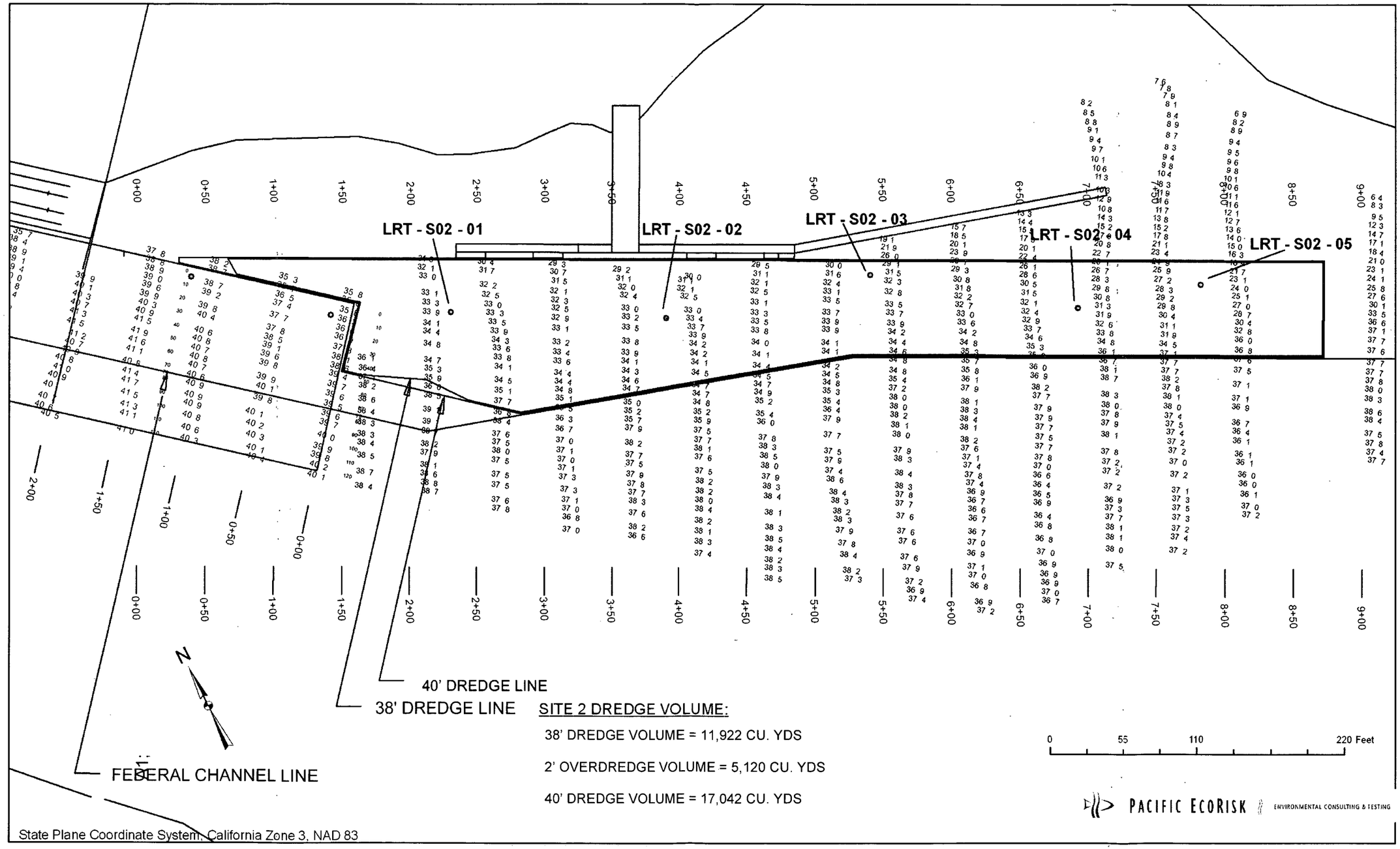


Figure B-2. Site LRT-S02 (Shore Terminal) Sediment Core Locations

Table B-1. Results of Grain Size Analyses of Shore Terminal Sediments.

Analytes	LRT-SO2 COMP	Method Reporting Limit
% Gravel	0.00	0.1
% Sand	13.3	0.1
% Silt	38.5	0.1
% Clay	49.6	0.1

Table B-2. Results of Conventional Analyses of Shore Terminal Sediments.

Analytes	LRT-SO2 COMP	Method Reporting Limit
Total Solids (% as Dry Wt.)	44.7	0.1
Total Organic Carbon (%)	1.14	0.1

Table B-3. Metals Concentrations (mg/kg, dry wt) of Shore Terminal Sediments.

Metals	LRT-SO2 COMP	Method Reporting Limit
Arsenic	7.0	0.5
Cadmium	0.40	0.05
Chromium	83.0	1.0
Copper	39.3	0.1
Lead	30.1	0.05
Mercury	0.35	0.02
Nickel	59.7	0.2
Selenium	0.2	0.1
Silver	0.38	0.02
Zinc	82.8	0.5

Table B-4. PAH Concentrations (μg/kg, dry wt) of Shore Terminal Sediments.

PAHs	LRT-SO2 COMP	Method Reporting Limit
Acenaphthene	<1	5.6-5.7
Acenaphthylene	<1	5.6-5.7
Anthracene	<1	5.6-5.7
Benzo(a)anthracene	8.1	5.6-5.7
Benzo(a)pyrene	11	5.6-5.7
Benzo(b)fluoranthene	12	5.6-5.7
Benzo(g,h,i)perylene	12	5.6-5.7
Benzo(k)fluoranthene	9.3	5.6-5.7
Chrysene	12	5.6-5.7
Dibenzo(a,h)anthracene	<1	5.6-5.7
Dibenzofuran	<1	5.6-5.7
Fluoranthene	14	5.6-5.7
Fluorene	<1	5.6-5.7
Indeno(1,2,3-cd)pyrene	10	5.6-5.7
Methylnaphtalene	<1	5.6-5.7
Naphthalene	<1	5.6-5.7
Phenanthrene	6.0	5.6-5.7
Pyrene	16	5.6-5.7
Total PAHs	110.4	NA

Table B-5. Organochlorine Pesticide Concentrations (µg/kg, dry wt) of Shore Terminal Sediments.

Organochlorine Pesticides	LRT-SO2 COMP	Method Reporting Limit
Aldrin	<1	1
a-BHC	<1	1
b-BHC	<1.1	1.1
g-BHC (Lindane)	<1	1
d-BHC	<1	1
alpha-Chlordane	<1	1
gamma-Chlordane	<1.6	1.6
Dieldrin	3.4	1
Endosulfan I	<1	1
Endosulfan II	3.1	1
Endosulfan sulfate	<1	1
Endrin	<1	1
Endrin aldehyde	<1	1
Endrin ketone	1.4	1
Heptachlor	<1	1
Heptachlor epoxide	1.2	1
Methoxychlor	<1	1
Toxaphene	<50	50
4,4'-DDD	83	10
4,4'-DDE	20	1
4,4'-DDT	35	1
Total DDT	138	NA

ABOVE 2011 BT

Table B-6. Total DDT Concentrations (µg/kg, dry wt) of Shore Terminal LRT-S02 Individual Sediment Core Samples.

Analyte	LRT-S02-01	LRT-S02-02	LRT-S02-03	LRT-S02-04	LRT-S02-05	Method Reporting Limit
4,4'-DDD	160	180	87	120	85	20
4,4'-DDE	31	35	21	26	33	20
4,4'-DDT	49	75	32	24	36	20
Total DDT	240	290	140	170	154	NA

Table B-7. Organotin Concentrations (µg/kg, dry wt) of Shore Terminal Sediments.

Organotins	LRT-SO2 COMP	Method Reporting Limit
Monobutyltin	<2.3	2.3
Dibutyltin	11	2.3
Tributyltin	18	2.3
Tetrabutyltin	<2.3	2.3
Total Butyltins	29	NA

Table B-8. PCB Aroclor Concentrations (µg/kg, dry wt) of Shore Terminal Sediments.

PCB Aroclors	LRT-SO2 COMP	Method Reporting Limit
Aroclor 1016	<10	10
Aroclor 1221	<20	20
Aroclor 1232	<10	10
Aroclor 1242	<10	10
Aroclor 1248	<10	10
Aroclor 1254	<31	31
Aroclor 1260	<10	10
Total PCBs	<10	NA

RLS TOO HIGH

Table B-9. *Ampelisca abdita* Survival in the Solid-Phase Test Sediments.

Sediment Site	% Survival in Test Replicates					Overall Mean % Survival
	Rep A	Rep B	Rep C	Rep D	Rep E	
"Home" Lab Control	100	95	95	90	90	**94**
Alcatraz (SF-11)	70	75	80	80	75	**76**
San Pablo (SF-10)	75	100	65	85	65	**78**
LRT-SO2 COMP	85	85	85	80	80	**83**

Table B-10. *Neanthes arenaceodentata* Survival in the Solid-Phase Test Sediments.

Sediment Site	% Survival in Test Replicates					Overall Mean % Survival
	Rep A	Rep B	Rep C	Rep D	Rep E	
"Home" Lab Control	100	90	100	100	100	**98**
Alcatraz (SF-11)	100	100	100	100	100	**100**
San Pablo (SF-10)	100	100	100	100	100	**100**
LRT-SO2 COMP	100	100	90	90	100	**96**

Table B-11. Effects of LRT-SO2 COMP Sediment Elutriate on *Mytilus sp.* Embryo Survival & Development.

Elutriate Treatment	Mean % Survival	Mean % Normal Development
Lab Control	93	93
1%	64	59
10%	91	83
25%	81	80
50%	66	62
100%	0	0
LC_{50} or EC_{50} =	57.9% elutriate	62.4% elutriate
Disposal limit met?	Yes	Yes

Appendix C

Previous Physical, Chemical and Biological Testing Results for the Levin-Richmond Terminal Corporation Berth A - Testing Performed in 2008

Table C-1. Sediment Grain Size Analysis Results.

Analytes	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient <40% Fines (SFRWQCB 1998)	Bay Ambient <100% Fines (SFRWQCB 1998)
% Gravel	46.4	12.1	29.7	30.3	3.9	-	-
% Sand	18.2	45.9	31.6	22.4	23.4		
% Silt	16.1	26.0	19.3	18.3	49.2		
% Clay	19.3	16.0	19.3	29.0	23.5		
Total % Fines <4 phi	35.4	42.0	38.6	47.3	72.7	-	-

Fines = silt + clays.

Table C-2. Sediment Metals Concentrations (mg/kg, dry wt), Total Solids (%), and Total Organic Carbon (%).

Metals	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRTC-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Arsenic	6.26	5.07	6.90	8.87	2.62	13.5	15.3
Cadmium	0.681	0.805	0.252	1.10	0.669	0.25	0.33
Chromium	50.8	49.9	51.8	79.3	47.4	91.4	112
Copper	39.0	31.0	34.5	53.2	93.4	31.7	68.1
Lead	72.3	19.1	21.1	29.5	19.8	20.3	43.2
Mercury	0.439	0.241	0.348	0.467	0.104	0.25	0.43
Nickel	47.5	47.9	47.5	70.5	47.2	92.9	112
Selenium	0.254	0.286	0.285	0.443	0.201	0.59	0.64
Silver	0.301	<0.165	<0.175	0.334	<0.133	0.31	0.58
Zinc	105	96.3	86.4	93.2	60.7	97.8	158
Total Solids (%.)	62.7	60.5	57.2	37.7	75.0	-	-
Total Organic Carbon (%)	1.86	1.39	1.12	1.64	0.46	-	-

All results below laboratory method detection limit (MDL) are reported as <MDL

Table C-3. Sediment Organotin Concentrations (μg/kg, dry wt).

Organotins	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Monobutyltin	<0.88	<0.91	<0.96	<1.46	<0.73	No data available	No data available
Dibutyltin	<1.83	<1.90	<2.01	<3.05	<1.53	No data available	No data available
Tributyltin	<1.58	<1.64	<1.73	<2.63	<1.32	No data available	No data available
Tetrabutyltin	<1.42	<1.47	<1.56	<2.36	<1.19	No data available	No data available
Total Detected Butyltins	**<1.42**	**<1.47**	**<1.56**	**<2.36**	**<1.19**	No data available	No data available

All results below laboratory method detection limit (MDL) are reported as <MDL.

Table C-4. Sediment PCB Aroclor Concentrations (μg/kg, dry wt).

PCB Aroclors	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Aroclor 1016	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Aroclor 1221	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Aroclor 1232	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Aroclor 1242	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Aroclor 1248	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Aroclor 1254	<1.49	44.8	5160	66.3	<1.25	see total PCB	see total PCB
Aroclor 1260	<1.49	<1.55	<1.64	<2.48	<1.25	see total PCB	see total PCB
Total Detected PCBs	**<1.49**	**44.8**	**5160**	**66.3**	**<1.25**	8.6	21.6

All results below laboratory method detection limit (MDL) are reported as <MDL.

Table C-5. Sediment PCB Aroclor Concentrations (μg/kg, dry wt): Re-analysis of LRTC-S01-03.

PCB Aroclors	Re-extraction of LRT-S01-03	Duplicate Analysis of Re-extracted LRT-S01-03	Analysis of Archived LRT-S01-03	Duplicate Analysis of Archived LRT-S01-03	Mean PCB Aroclor Concentration of LRTC-S01-3	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Aroclor 1016	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Aroclor 1221	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Aroclor 1232	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Aroclor 1242	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Aroclor 1248	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Aroclor 1254	448	338	249	203	310	see total PCB	see total PCB
Aroclor 1260	<16.4	<16.4	<17.9	<17.9	<17.2	see total PCB	see total PCB
Total Detected PCBs	**448**	**338**	**249**	**203**	**310**	8.6	21.6

All results below laboratory method detection limit (MDL) are reported as <MDL.

Table C-6. Sediment Organochlorine Pesticide Concentrations (µg/kg, dry wt).

Organochlorine Pesticides	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Aldrin	<0.16	<0.17	<0.18	<0.27	<0.14	0.42	1.1
a-BHC	<0.09	<0.09	<0.09	<0.14	<0.07	nd	<1
b-BHC	<0.14	<0.14	<0.15	<0.23	<0.11	nd	<1
g-BHC (Lindane)	<0.11	<0.12	<0.12	<0.19	<0.09	nd	<1
d-BHC	<0.13	<0.14	<0.14	<0.22	<0.11	nd	<1
Chlordane	<1.52	<1.57	<1.66	<2.53	<1.27	0.42	1.1
Dieldrin	33.5	2.27	<0.16	3.93	1.01	0.18	0.44
Endosulfan I	<0.13	<0.14	<0.15	<0.22	<0.11	nd	<1
Endosulfan II	<0.24	<0.25	<0.27	<0.40	<0.20	nd	<1
Endosulfan sulfate	<0.15	<0.16	<0.17	<0.25	<0.13	nd	<1
Endrin	<0.16	<0.16	<0.17	<0.26	<0.13	0.31	0.78
Endrin aldehyde	<0.10	<0.10	<0.10	<0.16	<0.08	nd	<1
Heptachlor	<0.23	<0.23	<0.25	<0.38	<0.19	nd	<1
Heptachlor epoxide	<0.22	<0.23	<0.24	<0.37	<0.19	nd	<1
Toxaphene	<5.61	<5.82	<6.15	<9.34	<4.69	nd	<10
2,4'-DDD	72.7	9.35	<0.43	15.7	3.63	see total DDT	see total DDT
4,4'-DDD	302	27.2	<0.17	46.9	11.4	see total DDT	see total DDT
2,4'-DDE	<17.2	<1.43	<0.38	<2.86	<0.58	see total DDT	see total DDT
4,4'-DDE	116	16.1	<0.16	12.7	4.10	see total DDT	see total DDT
2,4'-DDT	<31.9	<2.64	<0.70	<5.31	<1.07	see total DDT	see total DDT
4,4'-DDT	41.5	2.42	<0.11	16.8	1.03	see total DDT	see total DDT
Total Detected DDT	**532**	**55.1**	**<0.11**	**92.1**	**20.2**	2.8	**7.0**

All results below laboratory method detection limit (MDL) are reported as < the MDL

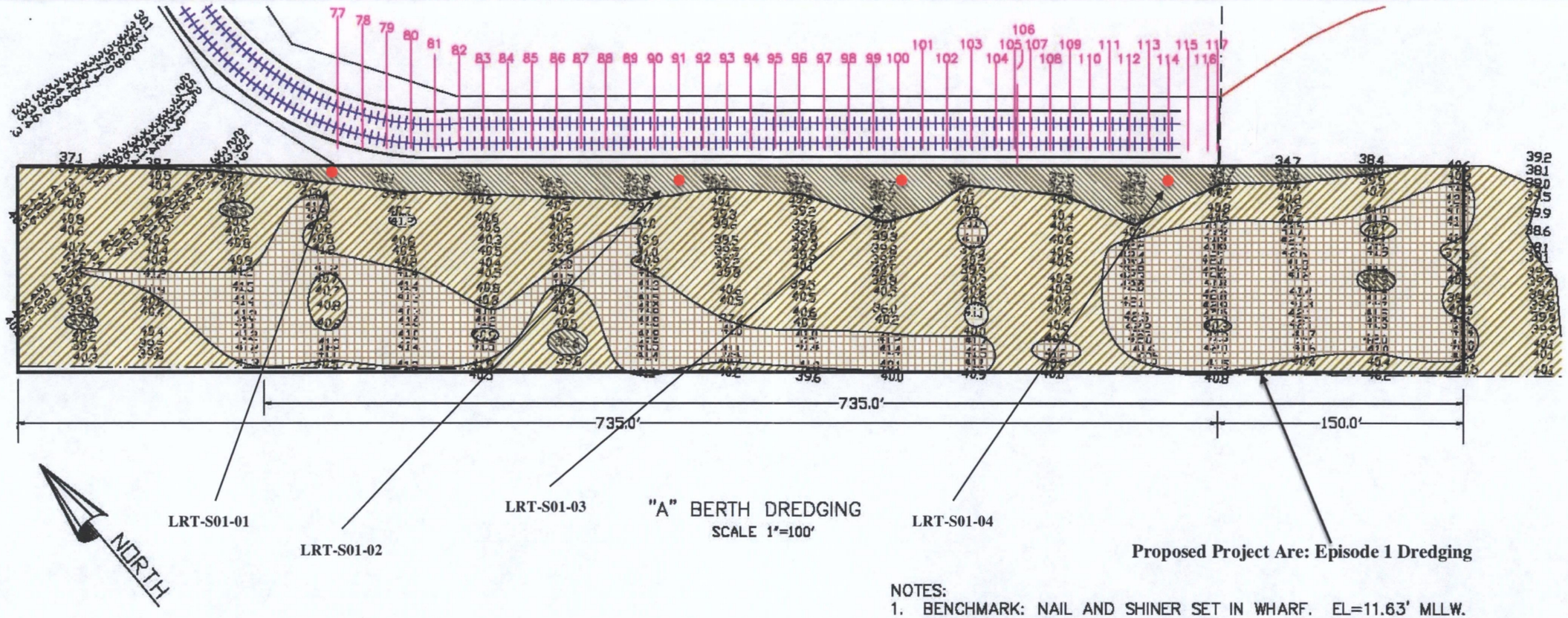
Table C-7. Sediment PAH Concentrations (µg/kg, dry wt).

PAHs	LRT-S01-01	LRT-S01-02	LRT-S01-03	LRT-S01-04	LRT-S01-Z-Layer Comp	Bay Ambient (RWQCB 1998) <40% fines	Bay Ambient <100% Fines (SFRWQCB 1998)
Acenaphthene	97.4	<5.95	95.0	<9.55	21.3	2.2	31.7
Acenaphthylene	9.25J	<7.74	<8.18	<12.4	<6.24	11.3	26.6
Anthracene	158	30.5	100	<16.7	17.6	9.3	88
Benzo(a)anthracene	333	81.3	72.8	29.9	18.1	15.9	244
Benzo(a)pyrene	231	90.1	62.2	35.3	17.5	32.1	412
Benzo(b)fluoranthene	329	107	80.6	43.8	24.1	29.2	371
Benzo(g,h,i)perylene	33.8	17.8	<17.0	<25.8	<13.0	22.9	310
Benzo(k)fluoranthene	131	43.1	32.5	<18.1	10.5	18.1	258
Chrysene	549	163	112	59.4	29.8	19.4	289
Dibenzo(a,h)anthracene	25.0	<15.2	<16.0	<24.4	<12.2	3	32.7
Fluoranthene	753	102	256	76.8	57.2	78.7	514
Fluorene	77.5	9.07	75.5	<12.4	17.8	4	25.3
Indeno(1,2,3-cd)pyrene	58.4	22.0	<17.5	<26.5	<13.3	19	382
Naphthalene	106	14.6	87.0	8.78	41.5	8.8	55.8
Phenanthrene	282	32.5	170	21.3	51.1	17.8	237
Pyrene	1180	197	261	120	98.7	64.6	665
Total Detected PAHs	**4350**	**909**	**1410**	**396**	**405**	**211***	**3390***

All results below laboratory method detection limit (MDL) are reported as <MDL.

J - Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.

*Total PAH value represents the 85th percentile total PAHs concentration (various combinations of above 16 PAHs). As a results the total PAHs is not equal to the sum of the 85th percentile concentration of the each individual PAH.



LEGEND

<-39'	
-39' TO -41'	
>-41'	

DREDGING VOLUMES

TO -39' =1,780 yds

TO -41' =5,126 yds

NOTES:

1. BENCHMARK: NAIL AND SHINER SET IN WHARF. EL=11.63' MLLW.
2. BATHMETRIC DATA SHOWN REPRESENTS WATER DEPTHS AT A 0.0 TIDE; ALL ELEVATIONS SHOWN ARE NEGATIVE, UNLESS NOTED OTHERWISE.
3. SOUNDINGS TAKEN BY FATHOMETER ARE SHOWN TO THE NEAREST TENTHS OF A FOOT.
4. COORDINATE VALUES ARE BASED ON THE CALIFORNIA COORDINATE SYSTEM, ZONE III, NAD '83.
5. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS RESULTS OF A HYDROGRAPHIC SURVEY MADE ON 08-29-08, AND INDICATES THE CONDITIONS AS OF THAT DATE.
6. SOUNDINGS WERE TAKEN USING AN ODOM HYDROTRAC ECHOSOUNDER; HORIZONTAL LOCATION BY LEICA RTK DGPS SOFTWARE UTILIZED IS COASTAL OCEANOGRAPHICS 'HYPACK'.
7. BACKGROUND LAND TOPOGRAPHIC DATA RECEIVED FROM LEVIN-RICHMOND TERMINAL.

2005

Figure C-1. Levin-Richmond Terminal Berth "A" Sample Locations

Appendix D

Sample Containers, Holding Time, Preservation and Storage for Analytical Chemistry

SAMPLE CONTAINERS, HOLDING TIMES, PRESERVATION AND STORAGE

PARAMETER	CONTAINER TYPE/SIZE	HOLDING TIME[a]	PRESERVATION/STORAGE
Metals[b]	125-mL glass jar	Mercury – 28 days All others – 6 months	Hold at 4°C ± 2°C up to 1 month or freeze at -20°C ± 10°C
Butyltins	500-mL glass with Teflon® lid	14 days to extraction[c]; 40 days to analysis after extraction	Freeze for extended storage (-20°C ± 10°C); otherwise store at 4°C ± 2°C
PCBs[d], pesticides[e], PAHs[f]	500-mL glass with Teflon® lid	14 days to extraction[c]; 40 days to analysis after extraction	Freeze for extended storage (-20°C ± 10°C); otherwise store at 4°C ± 2°C
Dioxins	500-mL glass with Teflon® lid	14 days to extraction[c]; 30 days to extraction[c] for Dioxins[c]; 40 days to analysis after extraction	Freeze for extended storage (-20°C ± 10°C); otherwise store at 4°C ± 2°C
Grain size	125-mL plastic	6 months	4°C ± 2°C
Total solids, TOC, ammonia	250-mL glass with Teflon® lid	Total solids, TOC – 1 month; ammonia – 7 days	4°C ± 2°C
Toxicity tests	4-L glass with Teflon® lid (1 container per acute test)	6 weeks	4°C ± 2°C/dark/airtight
Archive	500-mL and 1-L glass jars with Teflon® lid (for composite samples)	1 year	Freezer storage (-20°C ± 10°C)

NOTE: PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
TOC – total organic carbon

[a] Holding times begin the day the sediment sample is prepared in the filed.
[b] Arsenic, cadmium, chromium, copper, lead , mercury, nickel, selenium, silver, and zinc.
[c] Sample may be held for up to one year if stored at -20°C±10°C (USEPA/USACE 1998).
[d] PCBs as congeners, Aroclors 1242, 1248, 1254, 1260, and total PCBs (USEPA/USACE 1998).
[e] Chlorinated pesticides on USEPA Method 608 list (USACE 1993; USEPA/USACE 1998).
[f] PAH compounds on USEPA Method 610 list (USACE 1993; USEPA/USACE 1998).

Appendix E

Standard Operating Procedures

STANDARD OPERATING PROCEDURE

SEDIMENT CORE/SAMPLE COLLECTION – VIBRACORER

Sediment core samples may be collected with an electrically powered vibracorer, which is lowered through the water column under winch control, and which penetrates the sediment by means of its weight and intense vibration. The following steps outline the procedure for collection of sediment samples using a vibracorer.

1. Maneuver the sampling vessel to the proposed sampling location using the navigation system and deploy a marker buoy at the location.

2. Check to ensure that the metal core barrel is securely fastened to the powerhead of the vibracorer and insert a decontaminated core liner inside the metal core barrel.

3. Insert a core catcher in to the core nose so that the catcher fingers will extend into the core liner, and then screw the core nose onto the bottom of the core barrel.

4. Continue screwing the core nose until the shoulder on the inside of the core nose firmly contacts the end of the core barrel. Tighten the core nose with a spanner or strap wrench.

5. Start the electrical generator, but **DO NOT** energize the corer.

6. Signal the winch operator to hoist the corer and swing it over the stern or side of the vessel at the marked sampling location. Reposition the vessel if necessary. Record the measured water depth, and enter the tidal elevation on the core collection log sheet. Calculate the mudline elevation, and then determine the number of feet of penetration required to reach project depth.

7. Signal the winch operator to lower the corer through the water column. Determine the depth of the corer in the water column and track its subsequent penetration into the sediment either by marking the winch line in 1-ft increments or by attaching a flexible tape measure to the powerhead. In either case, the reference will be 0 ft at the tip of the core nose.

8. When the core nose is within approximately 10 ft of the bottom, energize the corer by actuating the circuit breaker on the generator control panel.

9. Slow the descent speed of the corer in order to determine when the core nose is entering the sediment. Maintain tension on the winch line throughout the coring process to keep the corer from topping over. The worker monitoring the penetration of the corer into the sediment will signal the winch operator when to pay out more line.

10. If refusal is encountered or if the measured distance to the tip of the core nose indicates that project depth has been reached, stop paying out line and de-energize the corer. Do not power down the generator. Refusal is indicated by less than 6 inches of penetration in a given 30-second interval.

11. Signal the winch operator to bring the winch line taut. Maneuver the boom or the boat until the winch pulley is directly above the corer in the sediment, as indicated by the winch line being as close to true vertical as possible.

12. Record the position of the actual coring location. The navigation antenna may be mounted on the winch boom near the pulley to place it directly over the corer.

13. Signal the winch operator to retrieve the corer. If the corer is stuck in the bottom, energize the power head while maintaining tension on the winch line. To reduce the risk of losing sediment from the core barrel, de-energize the corer over the deck and lower it to a holding rack. Note and record the length of smearing on the outside of the core barrel, which gives and indication of the amount of penetration.

14. Use a spanner or strap wrench to unscrew the core nose and remove it. The catcher may stay inside the core nose or remain attached to sediment inside the core liner. Retain any sediment in the core nose and catcher for examination and possible use.

15. Pull the corer liner approximately 6 inches out of the core barrel, remove the catcher (if necessary), and immediately cap the bottom end of the core liner with a plastic cap. Secure the bottom cap with duct tape and proceed to step 16.

    Alternatively, remove the core completely out of the core barrel and evaluate the appearance and length of the core sample by examination through the clear plastic core liner. Note any stratigraphic intervals or other salient features on the core collection log sheet. Extrude the sediment from the core liner and place into food-grade polyethylene bags on board the sampling vessel and proceed to step 25.

16. Extract the core liner entirely from the core barrel, and immediately cap the top of the core liner.

17. If the core is to be cut into length-wise sections, draw a mark on the outside of the core liner where the cut will be made to cut off the bottommost section. Apply duct tape and use a permanent marker to mark the sections on both sides of the location of the future cut. Mark arrows pointing toward the top end of the core, write the core ID, write date and time, and indicate the depth interval spanned by the sections in terms of feet below mudline.

18. Three individuals are needed to complete the cutting process: One person will make the cut with a saw loaded with a decontaminated blade, and two persons will tend the cut ends of the sections.

19. Make the cut and immediately cap both the exposed ends. Immediately secure both caps with duct tape.

20. Repeat the cutting procedure if more length-wise sections need to be cut.

21. Remove the cap from the top end of the top-most section and drain the water. Draining may be accomplished by drilling the hole through the core liner just above the top of the sediment or by gently tipping the section to empty the water out the top. The latter approach may be risky if the sediments are watery or loose.

22. Cut off the excess plastic tube and immediately cap the end and secure the cap with duct tape.

23. If the core will consist of only one section, do steps 15 and 16, mark the core liner as described in step 17, and then do steps 21 and 22.

24. Evaluate the appearance and length of the core sample by examination through the clear plastic core liner. Note any stratigraphic intervals or other salient features on the core collection log sheet.

25. Fill out a chain-of-custody form for the core section(s) to initiate the tracking process.

26. Store the core sections at 4°C (± 2°C) in a refrigerator or iced cooler.

27. Complete any additional entries on the core collection log sheet.

<u>Acceptance criteria for a sediment core sample are as follows:</u>

- The core penetrated to and retained material to project depth or refusal and shows evidence of Merritt Sand.

- Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.

- There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core and resulted in incomplete core collection.

- If sample acceptance criteria are not achieved, the sample will be rejected. If repeated deployment within 25-50 ft of the proposed location does not result in a sample that meets the appropriate acceptance criteria, the Project Manager will make a decision regarding relocating the proposed sample location.

STANDARD OPERATING PROCEDURE

LABORATORY SEDIMENT CORE/SAMPLE PROCESSING

The following steps outline the general procedure to be followed. The number and subdivisions of berths and composites may vary, depending upon a particular sampling episode.

1. All equipment coming into contact with sediment will be decontaminated before use with each sample to avoid cross contamination.

2. Extrude the sediment from the core liner into a stainless-steel bowl or a 5-gallon high-density polyethylene (HDPE) bucket, depending on the volume.

3. Examine the sediment and record descriptive notes on the core collection log sheet. Parameters may include:
   a. Qualitative sediment description
   b. Odor
   c. Debris
   d. Biological activity (e.g., detritus, shells tubes, bioturbation, live or dead organisms)
   e. Presence of oil sheen
   f. Any other distinguishing characteristics

4. After the sediment description is complete, homogenize the sediment by hand using a stainless-steel mixing spoon or by using an electric drill with a stainless-steel stirring paddle.

5. Once the sediment has been homogenized, immediately collect a sample for sulfide analysis prior to any other processing. Use a stainless-steel spoon to place sediment into a 4-oz jar. Fill the jar two-thirds full and preserve with one vial of zinc acetate supplied by the analytical laboratory. Immediately screw on the lid, label the jar, and place it in a cooler supplied with ice or frozen blue ice packets.

6. Collect a sample of the homogenized sediment from the individual core for archiving. Fill one 16-oz sample container three-fourths full, screw on the lid, label the jar, and place it in freezer storage for archival purposes.

7. Use aluminum foil or a filtered lid to close the container of homogenized sediment until the remaining cores of the group to be composited for that site have been similarly processed.

8. In a 10-gallon HDPE bucket, combine equal portions of sediment from each individual core of the group to be composited and mix thoroughly (e.g., with an electric drill and stainless-steel paddle) until uniformly homogenized.

9. Collect a sample of the homogenized composite for archiving by filling a 32-oz sample jar three-fourths full, screwing the lid on tightly, labeling the jar, and placing it in freezer storage.

10. Distribute the composited homogenized site sediment to the appropriate sample jars, label the jars, complete the core processing log form and sample tracking form, and place the jars in refrigerated storage for subsequent packing and shipping to analytical laboratories.

11. If it is necessary to archive sediment for possible use in bioassays, ensure that all sample jars for analysis have been filled, then collect two 64-oz glass containers per bioassay.

12. Throughout the sample processing phase, maintain secure storage of sediment and samples; that is, observe proper custody procedures, and continue those procedures until the sample shipping containers are released to the shopping carriers.

13. Any sediment remaining from individual cores that was not used in preparing the homogenized composite should be archived at 4°C for potential subsequent analysis of the individual cores.

Appendix F

Bioassay Standard Test Conditions

Summary of Test Conditions and Acceptability Criteria for the Amphipod (*Ampelisca abdita*) 10-Day Sediment Toxicity Test.		
1.	Test type	Static non-renewal
2.	Test duration	10 d
3.	Temperature	20 ± 1°C
4.	Salinity	20 – 35 ppt
5.	Light quality	Ambient Laboratory
6.	Light intensity	50 – 100 ft c.
7.	Photoperiod	Continuous
8.	Test chamber size	1 L
9.	Seawater volume	800 mL
10.	Sediment depth	40 mm
11.	Renewal of seawater	None
12.	Age of test organisms	Wild population, immature juveniles
13.	# of organisms per test chamber	20
14.	# of replicate chambers/concentration	5
15.	# of organisms per sediment type	100
16.	Feeding regime	None
17.	Test chamber cleaning	Lab washing prior to test
18.	Test solution aeration	Low bubble (~100/minute)
19.	Overlying water	0.45 μm-filtered seawater (at test salinity)
20.	Test materials	Test sites, reference and control
21.	Dilution series	None
22.	Endpoint	% Survival
23.	Sample holding requirements	< 8 weeks
24.	Sample volume required	4 L
25.	Test acceptability criteria	≥ 90% survival in the Control treatment
26.	Reference toxicant results	Within 2 SD of laboratory mean

Summary of Test Conditions and Acceptability Criteria for the Marine Polychaete (*Neanthes arenaceodentata*) 10-Day Sediment Toxicity Test.		
1.	Test type	Static-renewal
2.	Test duration	10 d
3.	Temperature	20 ± 1°C
4.	Salinity	20 – 35 ppt
5.	Light quality	Ambient Laboratory
6.	Light intensity	50 – 100 ft c.
7.	Photoperiod	12L/12D
8.	Test chamber size	1 L glass beakers
9.	Test solution volume	800 L
10.	Sediment depth	25 mm (200 mL)
11.	Renewal of seawater	None, unless needed. If needed, renew 80% of overlying water at 48 hour intervals
12.	Age of test organisms	2-3 weeks
13.	# of organisms per test chamber	5
14.	# of replicate chambers/concentration	5
15.	# of organisms per sediment type	25
16.	Feeding regime	None
17.	Test chamber cleaning	Lab washing prior to test
18.	Test solution aeration	Low bubble (~100/minute)
19.	Overlying water	0.45 μm-filtered seawater, at test salinity
20.	Test concentrations	Test sites, reference and Control
21.	Dilution series	None
22.	Endpoint	Survival
23.	Sample holding requirements	< 8 weeks
24.	Sample volume required	4 L
25.	Test acceptability criteria	≥ 90% survival in the Control treatment
26.	Reference toxicant results	Within 2 SD of laboratory mean

Summary of Test Conditions and Acceptability Criteria for the Mussel (*Mytilus galloprovinciales*) Water Column Toxicity Test.	
1. Test type	Static non-renewal
2. Test duration	48 hours
3. Salinity	28 – 32 ppt
4. Temperature	16 ± 1°C (mussels)
5. Light quality	Ambient Laboratory
6. Light intensity	50 –100 ft c.
7. Photoperiod	16L/8D
8. Test chamber size	20 mL vials
9. Test solution volume	10 mL
10. Renewal of seawater	None
11. Age of test organisms	Embryo ≤ 4h old
12. # of organisms per test chamber	150 – 300
13. # of replicate chambers per concentration	5
14. # of organisms per concentration	750 – 1,500
15. Feeding regime	None
16. Test chamber cleaning	Lab washing prior to test
17. Test chamber aeration	None
18. Elutriate preparation water	Site water
19. Test concentrations	Test sites, and Lab Control
20. Dilution series	Four concentrations (1, 10, 50, 100%) and a Lab Control.
21. Dilution water	Natural seawater
22. Endpoints	%Survival and %normal development
23. Sampling holding requirements	< 8 weeks
24. Sample volume required	2L
25. Test acceptability criteria	≥70% survival and normal development in the Lab Controls, <10% abnormal in Lab Control

Summary of Test Conditions and Acceptability Criteria for the Mysid (*Americamysis bahia*) Water Column Toxicity Test.	
1. Test type	Static non-renewal
2. Test duration	96 hours
3. Salinity	25-30 ppt ± 10 ppt
4. Temperature	20 ± 1°C
5. Light quality	Ambient Laboratory
6. Light intensity	50 –100 ft c.
7. Photoperiod	16L/8D
8. Test chamber size	400 mL beaker
9. Test solution volume	200 mL
10. Renewal of seawater	None
11. Age of test organisms	1-5 days; 24 hour range in age
12. # of organisms per test chamber	10
13. # of replicate chambers per concentration	5
14. # of organisms per concentration	50
15. Feeding regime	daily
16. Test chamber cleaning	Lab washing prior to test
17. Test chamber aeration	If needed to maintain >40% saturation
18. Elutriate preparation water	Site water or Clean sea water
19. Test concentrations	Test sites, and Lab Control
20. Dilution series	Four concentrations (1, 10, 50, 100%) and a Lab Control.
21. Dilution water	Natural seawater/artificial seawater
22. Endpoints	% Survival
23. Sampling holding requirements	< 8 weeks
24. Sample volume required	2L
25. Test acceptability criteria	≥90% survival in the Lab Controls

Summary of Test Conditions and Acceptability Criteria for the Inland Silverside (*Menidia beryllina*) Water Column Toxicity Test.	
1. Test type	Static non-renewal
2. Test duration	96 hours
3. Salinity	5 – 32 ppt ± 10 ppt
4. Temperature	20 ± 1°C
5. Light quality	Ambient Laboratory
6. Light intensity	50 –100 ft c.
7. Photoperiod	16L/8D
8. Test chamber size	400 mL beaker
9. Test solution volume	200 mL
10. Renewal of seawater	None
11. Age of test organisms	9-14 days; 24 hour range in age
12. # of organisms per test chamber	10
13. # of replicate chambers per concentration	5
14. # of organisms per concentration	50
15. Feeding regime	At 48 hrs
16. Test chamber cleaning	Lab washing prior to test
17. Test chamber aeration	If needed to maintain >40% saturation
18. Elutriate preparation water	Site water or Clean sea water
19. Test concentrations	Test sites, and Lab Control
20. Dilution series	Four concentrations (1, 10, 50, 100%) and a Lab Control.
21. Dilution water	Natural seawater/artificial seawater
22. Endpoints	%Survival
23. Sampling holding requirements	< 8 weeks
24. Sample volume required	2L
25. Test acceptability criteria	≥90% survival in the Lab Controls

Summary of Test Conditions and Acceptability Criteria for the Bioaccumulation Testing Using *Macoma nasuta* and *Nereis virens*.	
1. Test type	Static-renewal
2. Test duration	28-days
3. Salinity	>25 ppt
4. Temperature	12-16 ± 1°C
5. Light quality	Ambient Laboratory
6. Light intensity	50 –100 ft c.
7. Photoperiod	16L/8D
8. Test chamber size	12-L tank
9. Test sediment/test solution volume	4-L sediment/8-L water
10. Renewal of seawater	3x per week
11. Age of test organisms	*Macoma* 2-4 years, 28-45 mm shell length; *Nereis* large adults
12. # of organisms per test chamber	20 *Macoma*/10 *Nereis* (or as needed)
13. # of replicate chambers per concentration	5
14. # of organisms per concentration	100 *Macoma*/50 *Nereis* (or as needed)
15. Feeding regime	None
16. Test chamber cleaning	As needed
17. Test chamber aeration	Moderate as needed
18. Elutriate preparation water	Site water or Clean sea water
19. Test concentrations	Test sediment, reference sediment, and a Lab Control sediment
20. Dilution series	N/A
21. Dilution water	Natural seawater/artificial seawater
22. Endpoints	Bioaccumulation
23. Sampling holding requirements	< 8 weeks
24. Sample volume required	≥25-L
25. Test acceptability criteria	Adequate mass of organisms at test completion for detection of target analytes